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POWER

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Volume 67 New York, January 31, 1928 *Number 5*

Easy to Keep Your Record Good

LAST week I said that with the electrical measurement of power and with the improved methods of handling, measuring and weighing fuel, water and steam now available, the keeping of power-plant records had become comparatively easy.

The development of other instruments and appliances has made it easy to analyze these records and to indicate the course that should be followed for their improvement.

When the engineer got an idea that his engine was using too much steam and knew the valves and pistons were tight, he put an indicator onto it, if he had one, and saw how it was working.

When the modern engineer finds his boiler efficiency low, he analyzes the gases coming from the furnace and finds out how complete the combustion has been and how much unnecessary air he has been putting through to cool the furnace down.

There are simple instruments for this that can be handled, and the indications of which can be understood by the intelligent power plant operator.

They are to the furnace what the indicator is to the engine.

In the old days the principal concern of the engineer was for his engine. He tried to have it run so smoothly that he could balance a silver quarter on the flange of the cylinder and get a diagram from it like the picture in the books.

Power printed pages of articles showing that there were vastly greater savings to be made in the boiler room.

The complicated process of combustion was turned over to a husky with no other tools than a coal scoop and a slice bar and nothing to go by but a pressure gage and a water column.

There are now available draft gages, thermometers for the escaping gases and the incoming water, materials for keeping the baffles and the setting tight, and even control systems that automatically apportion the fuel to the load and the air to the fuel. There are processes and appliances for keeping the fire and water surfaces clean with such convenience as to encourage their frequent use.

Neglect to take advantage of these improvements is costing power-plant owners a lot of money.

F. R. Low

$60,000 per Year

To Be Saved by Revamping Old Power Plants

By J. J. Daley

By reconditioning equipment that had been in service for years in two distinct plants, shutting down one boiler room and raising the settings in the other, improving the water supply and purchasing current during the summer, an efficient plant was produced that will effect a saving in operating expense exceeding $60,000 per year

IN MOST industrial concerns that expand gradually into large establishments, the time usually comes when the power demand increases to a point where a survey and revamping of power plant conditions have to be considered. Such a survey often involves radical changes, and large amounts of money must be expended in order to produce adequate returns on the investment.

A condition of this kind existed in the factories of a nationally known manufacturing concern in the Chicago district. Over a long period of years changes in manufacturing conditions had so altered service requirements that the existing power plants were wasteful in operation and inadequate to insure continuity of service.

Throughout the entire establishment 220-volt direct-

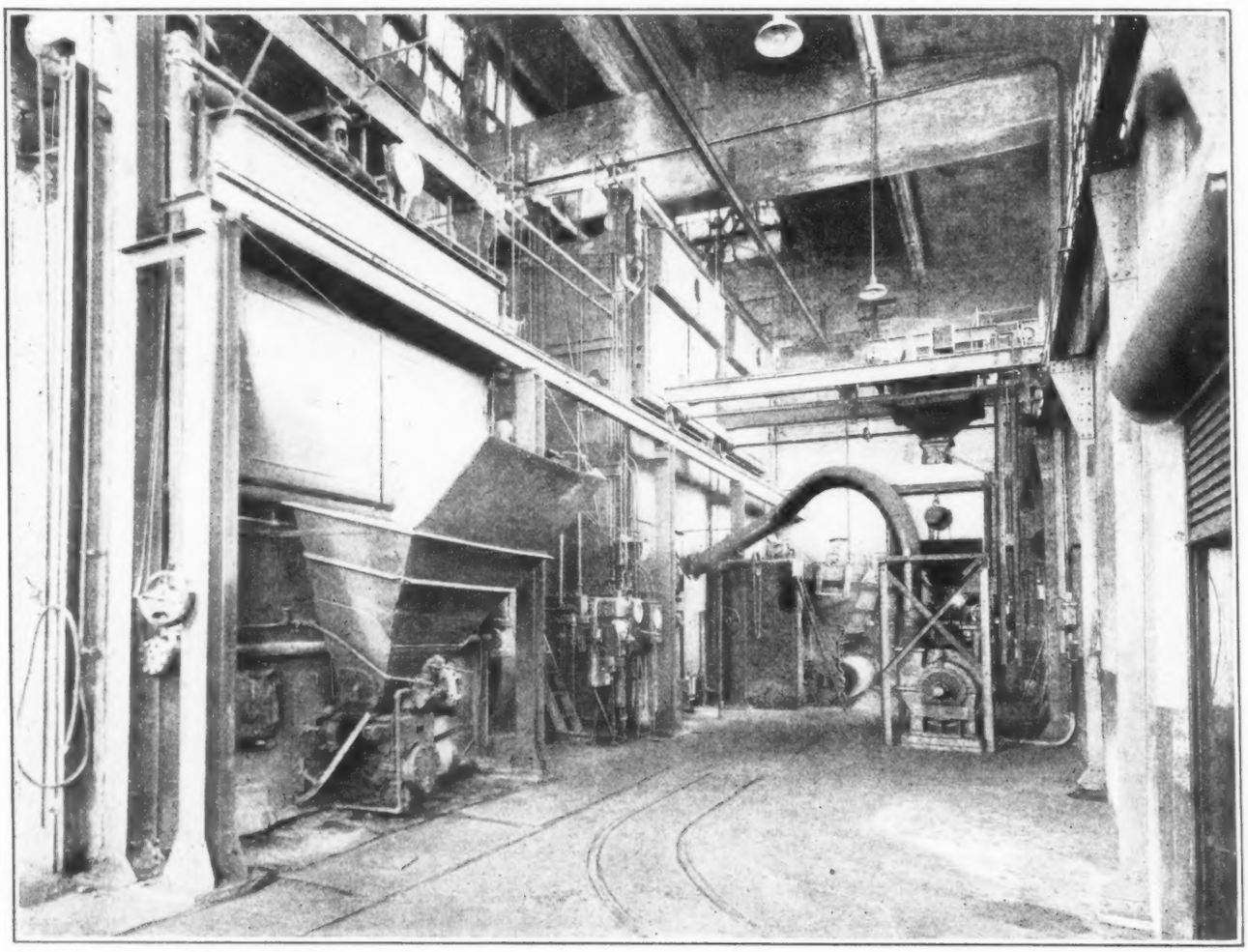


Fig. 1—Present boiler room as equipped for trial period: two of the boilers have been reset sixteen feet above the floor, while the boiler in foreground has its original setting

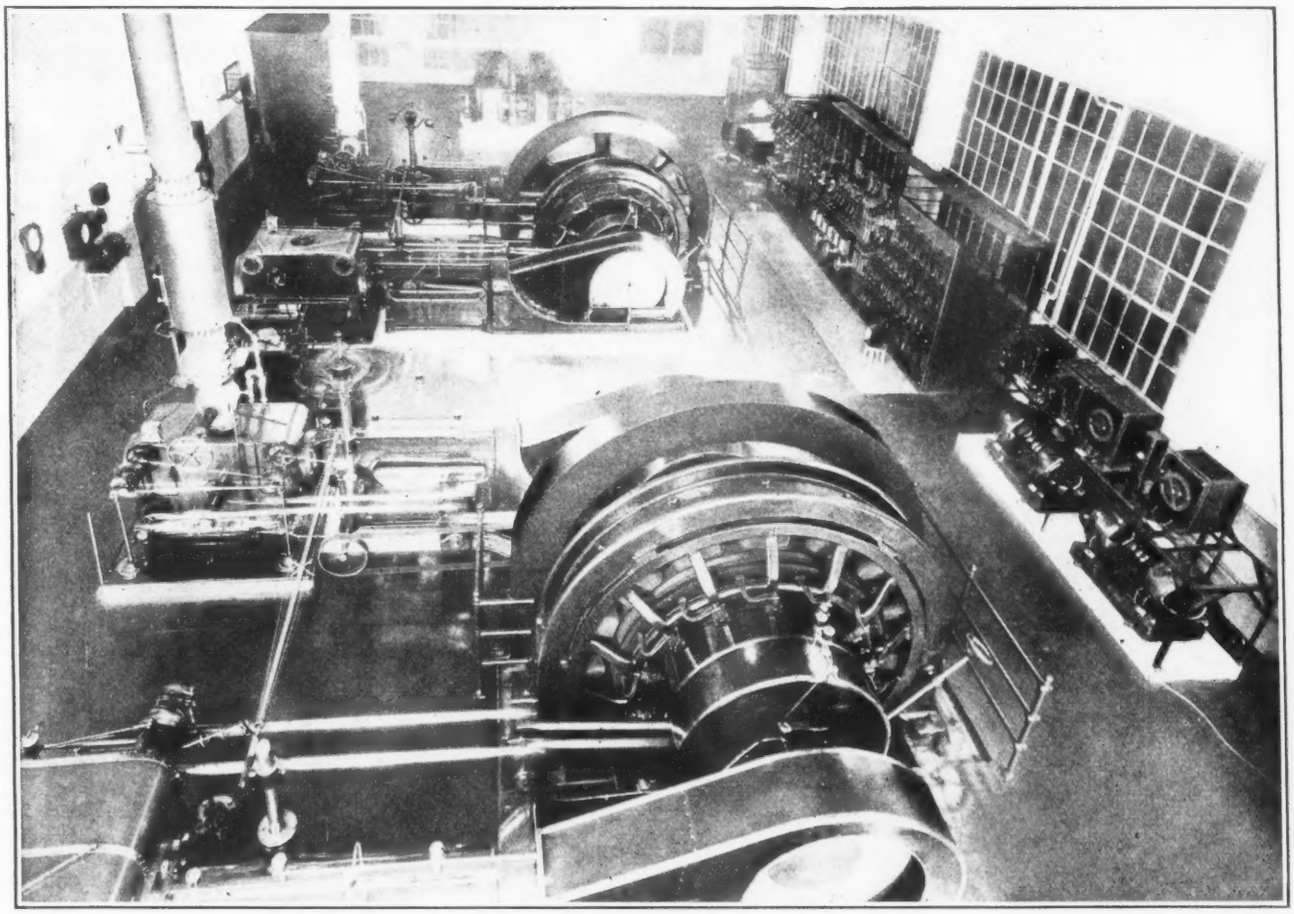


Fig. 2—Cross-compound Corliss engine generating units in plant B

current motors were used, and power, heat and light were furnished a group of buildings from two power plants approximately 1,600 ft. apart. The older of these plants, built in 1906, will be designated as plant A; the second plant, installed some years later, as plant B. The former contained four 2,500-sq.ft. water-tube boilers, two ten years, one fifteen years and the other thirty years old. All the boilers were fired with standard underfeed two-retort stokers, having a capacity with West Virginia or eastern Kentucky coal of about 1,200 lb. per retort. Forced draft was supplied by a blower provided with a dual drive, consisting of a steam engine and a motor. The working pressure carried was 110 to 115 lb. gage. Coal for these stokers was shoveled into a bucket on a larry at the bunker and wheeled onto a platform scale, weighed, and then lifted with a hydraulic hoist to be discharged into the stoker hopper.

All the fire pumping equipment was at this plant so that steam had to be maintained for this service. The pumproom contained a 750-g.p.m. fire pump, two 500-g.p.m. motor-driven service pumps and for air-lift service, a 700-c.f.m. uniflow steam duplex air compressor and a horizontal motor-driven air compressor. The makeup supply of feed water was treated by a lime and soda intermittent system.

Generating capacity aggregating 490 kw. was made up of three Corliss steam engines belted to 240-volt direct-current generators, one of 115-kw. and two of 150-kw. capacity, and one 75-kw. turbine unit.

Plant B contained three 4,000-sq.ft. water-tube boilers, stokered to operate at a maximum of not over 175 per cent rating, but this was practically impossible to obtain, as the boilers were set only eight feet above the floor. Two type-E stokers and one chain grate made up the firing equipment. Ashes were handled by an automatic ash ejector and the coal in practically the same way as described in plant A. Feed for the boilers was provided by the returns from the heating system and makeup water from the softener in plant A, as the well water in this building was hard, containing up to 39 grains of solids to the gallon. The pumproom contained the usual steam-driven vacuum return pumps, a triplex motor-driven feed pump and a direct-acting feed pump.

To generate the 240-volt direct current needed in the factory, two generating units, driven directly by compound Corliss engines, were provided, one rated at 500 kw. and the other at 350. Both operated non-condensing, exhausting into the atmosphere or against two pounds back pressure during the heating season. Primary steam conditions were 150 lb. pressure and superheat of approximately 75 deg. Meters were provided to measure the feed water and the steam flow from each boiler. On the electrical end totalizing wattmeters recorded the total output of the generators.

As the cost of service from these two plants was known to be excessive and their capacity did not provide for future extension, the engineering division of the organization was called upon to make a careful study of

several plans that would provide proper relief and produce the greatest returns on the investment. As a basis for determining the predicated operating costs under the different plans, operating costs for 1925 were used.

The first plan was to build a modern, new, central power plant that would economically meet the demand throughout the year for power, light and heat.

In plan 2 it was proposed to purchase public service current during the six summer months and generate current for the rest of the year, operating non-condensing so-that the exhaust steam could be used for heating the buildings. A further modification of this plan was to run an underground steam line from plant B to the engine room of plant A, so that the more wasteful boiler plant could be shut down and all steam furnished from a single source of supply.

Plan 3 called for the generation of all current, with certain additions to present equipment that would improve economy and provide for future expansion.

A summary of the investments that would be required in each case and cost of operation is given in Table I.

TABLE I—COMPARATIVE INSTALLATION AND OPERATING COSTS

	Cost of Installation	Cost of Operation
Present conditions	.....	$125,709.00
Plan 1	$460,000.00	74,058.00
Plan 2	108,000.00	119,505.00
Plan 3	300,000.00	78,580.00

From the figures given it will be seen that the greatest economy for the least expenditure of money could be obtained by carrying out plan 2, involving an expenditure of approximately $150,000, the $108,000 given in the table covering the cost of the installation to receive outside power and the motor-generator sets, and the balance representing the cost of the underground high-pressure steam and return line conduit connecting A and B plants.

The scope of the change consisted of the purchasing of three-phase 60-cycle alternating current at 12,000 volts, installing equipment in a substation built for the purpose and the stepping down of this high-tension current to 2,300 volts for distribution through ample sized cables to both engine rooms for the operation of motor-generator sets to furnish direct current.

The 2,300-volt current is conducted through 500,000-circ.mil lead-covered cables, laid in stone conduits with generous excess capacity of ducts to take care of future requirements. Manholes were placed at suitable places to enable connections to be taken in direct to each building as the occasion demanded. In engine room B a 500-kw. and a 250-kw. motor-generator set were installed. Each generator is driven by a 2,300-volt motor controlled through a modern high-tension truck-type alternating-current switchboard. Similar equipment was placed in engine room A to serve a 500-kw. motor generator, and a service connection was taken off the 2,300-volt line to a transformer room adjoining engine room B, to two 75-kva. 2,300-230 volt transformers making up the initial installation to serve the factories with low-tension alternating-current service for power and light.

It was recognized that the use of direct current for power in modern industry was being rapidly supplemented by alternating current, and during the next ten years this evolution is expected to be brought about gradually at the least expense in this factory group.

Fig. 3—Lower half of steam line conduit laid in crushed rock; multiple pipe supports on saddles

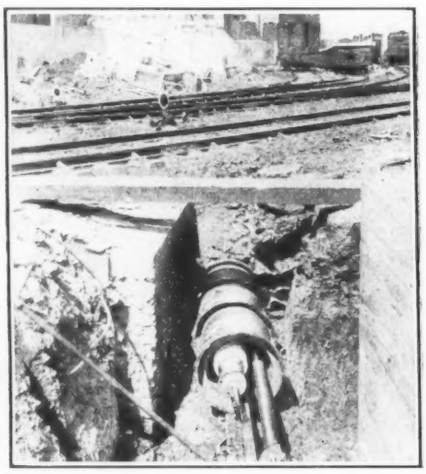


Fig. 4—Tile conduit with steam and return lines in place

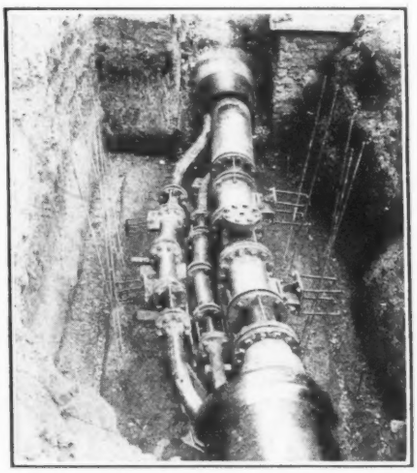


Fig. 5—Manhole for expansion joints in steam and return lines before placing form for concrete

To carry the underground steam and return lines, the former being 7 in. in diameter and the latter 3 and 2 in. respectively, a 20-in. vitrified tile conduit was laid about five feet underground for a distance of approximately 1,500 ft. The tile has been laid in a bed of crushed stone with drain tile beneath for the entire length. In no portion of the piping system are there threaded joints. All pipe sections and flanges are butt welded and have been tested to a hydrostatic pressure of 300 lb., maintained for a period of three hours without showing any leakage. The 7-in. steam pipe was covered with a double thickness of 85 per cent magnesia and waterproofed with roofing felt properly applied. After laying the upper half of the 20-in. tile, the top was completely sealed over with cement and the trench backfilled. Throughout the length of the line five manholes were provided, and in each suitable double-expansion sleeves were installed to take care of expansion and contraction.

When this steam line was completed, the four 2,500-

sq.ft. boilers at plant A were shut down and the three boilers in plant B now furnish steam for the entire group of buildings. The present engine-driven generators have been retained and with certain reconditioning will give satisfactory service for years to come.

Investigation disclosed that water could be purchased from the village at lower cost than by pumping the supply from deep wells on the premises by an air-lift system.

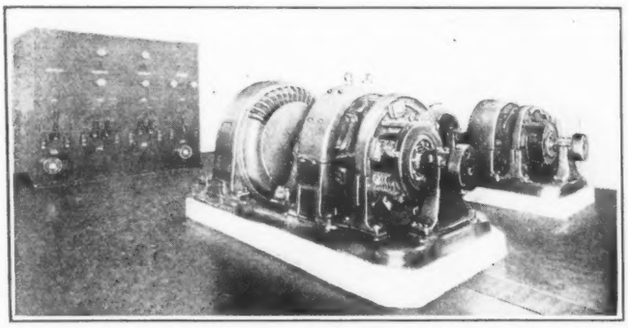


Fig. 6—Motor-generator sets and alternating-current switchboard in plant B

Besides, the village water was softer and thus more desirable, so that while this water is now being purchased with highly satisfactory results, the present pumping equipment is being retained intact, as an emergency supply for fire service.

Another innovation was the shutting down of the gas-producer plant when service became available from a public service company. The supply was brought into the factory through a 15-in. main, and all other surface connections to the various buildings were disconnected. Three automatically controlled motor-driven gas boosters of 13,500 cu.ft. per hour capacity each, and one 40,000-cu.ft. engine-driven gas booster were installed to raise the gas pressure from 6 in. of water to 4 lb. for distribution to all points where gas is required in the factories.

Two Sources of Power

Summarizing, there are two sources of power, one the reconditioned engine-driven generators, and the other the public service supply, either source being capable of supplying all demands; an ample supply of gas protected with duplicate sets of boosting units, either steam or electric driven; an ample supply of water with two sources to draw from if the necessity arises. The only weak spot is the boiler room, which is not provided with enough boiler capacity to take a boiler out of service during the heating season.

During the winter months of 1926-27, it was decided to operate the boiler plant as it stood and then, after observing the operating conditions, determine whether to install an additional boiler or reset the present ones. A study of the steam demand disclosed that the average load during the cold weather was in the neighborhood of 48,000 lb. of steam, reaching a peak of 60,000 lb. at zero temperatures. With three 4,000-sq.ft. water-tube boilers to furnish the steam and with the boilers set eight feet above the floor, it was found that the three boilers had to be operated all of the time.

With insufficient space available to install an additional boiler, set according to modern standards, it was considered that the better plan would be to reset two of the present boilers to a height of 16 ft. above the floor, replace one of the type-E stokers with a unit pulverizer and, from the results obtained, decide whether to replace the other underfeed stoker and the chain grate with unit pulverizers during the summer of 1928.

An additional sum of $38,000 was expended in raising the two boilers set in one battery and installing a traveling weigh larry in the boiler room for handling coal. The close approach of the heating season required postponing the completion of the program until next summer. As the plant now stands, two of the 4,000-sq.ft. boilers have been reset to a height of 16 ft. above the floor. The chain grate under one boiler has been retained and for the other the type-E stoker has been replaced with a unit pulverizer. Both the chain grate and the pulverizer are being operated at 200 per cent rating, which is not up to the maximum limit, as the chain grate has been operated for a short period of time up to 300 per cent rating and the same capacity can be expected from the pulverizing equipment.

Smaller Boiler for Summer Service

During the summer months, when the demand for steam is small, owing to the purchase of power and light, a 4,000-sq.ft. boiler equipped with a unit pulverizer would be too large for flexibility of operation. To overcome this condition, one of the 2,500-sq.ft. boilers previously shut down in plant A is to be reset in the present boiler room. To facilitate the treatment of makeup water, a Permutit water softener in the present boiler room has replaced the old lime and soda equipment in plant A.

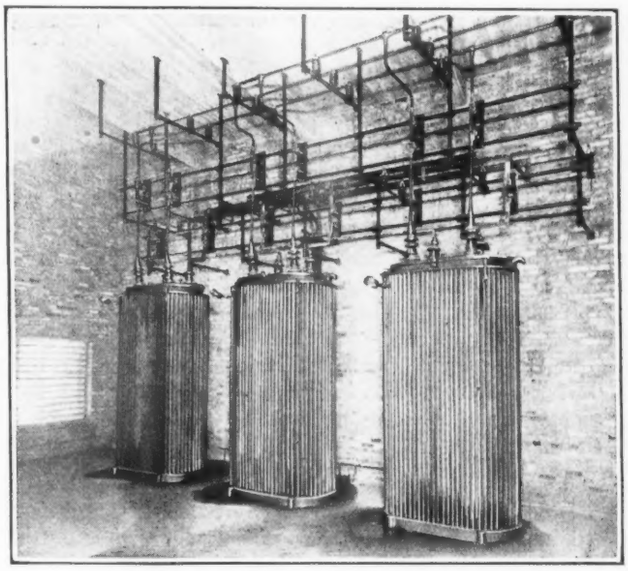


Fig. 7—Bank of 500-kw. 12,000-2,300-volt transformers in substation

When the final changes have been completed in the boiler room, the total expenditure will be in the neighborhood of $233,000, consisting of $108,000 for the electrical work, $42,000 for the underground steam line, both completed in the fall of 1926, $38,000 expended in the fall of 1927 for raising the two boilers and the initial

start on the coal handling system. The balance of $45,000 is to be expended in the summer of 1928, and will complete the program so far as the power plants are concerned.

As related in the foregoing, a modern economical source of supply for power, heat, light and auxiliary service has been deeded to the factory group for many years to come. This plant has been built up from equipment, some of which has been serving over a period of thirty years, subject to the many modifications that have taken place during that time. The plant now provides duplicate equipment as insurance against curtailment of production from breakdown and returns savings in operation that will wipe out the additional capital expenditure in a comparatively short time. Summarized, the principal operating costs for the three years, 1925 to 1927, inclusive, are given in Table II.

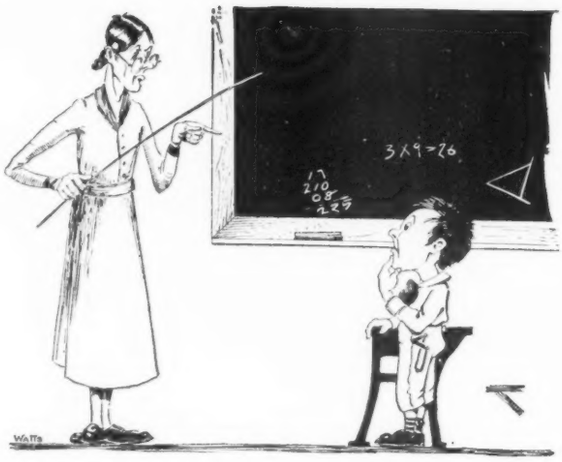
TABLE II—SUMMARY OF OPERATING COSTS FOR THREE YEARS

	1925	1926	1927
Tons coal used	15,025	12,922 13	9,108
Cost of handling coal	$506.11	$1,306.90	$1,037.57
Cost of coal	66,035.70	52,325.44	37,005.38
Cost of supplies	4,364.92	2,609.49	2,248.50
Cost of water	9,857.91	7,028.44	871.10
Cost of labor	33,112.71	27,191.42	23,745.23
Cost of repairs	27,918.21	15,997.62	5,354.82
Cost of insurance	50.52	100.02	64.56
Purchased current	.....	18,406.95	32,981.66
Miscellaneous	.....	16.20	216.76
	$141,846.08	$124,982.48	$103,525.58
Credit from public service company	.....	.....	2,258.94
Net total			$101,266.64
Saving, 1926 over 1925	$16,863.60		
Saving, 1927 over 1925	$40,579.44		

The costs in 1925 were used as a basis of comparison, even though the operating costs had been lowered considerably over what they had been during previous years, principally because a standard system of record keeping had been established at that time.

The full effect of the savings will not be realized until the boiler room improvements are completed in 1928. At that time it is expected that the boiler efficiency will be raised fifteen points, which will reduce the coal costs approximately 25 per cent, amounting to a further saving of $16,000 in coal and a labor saving of approximately $4,000. This will bring the total yearly saving in operating expense over the year 1925 to an amount exceeding $60,000. It will be recalled that this does not take into consideration the savings made in 1925 over previous years.

A SUMMARY OF THE ACTIVITIES of the operating electric light and power companies during 1927 prepared by the National Electric Light Association shows that the electrical industry has enjoyed a healthy normal progress during the past year, while proposed extensions and new installations indicate that 1928 will witness new high marks in generation and earnings. The total output of electricity from the operating electric utilities reached a production of 79,000,000,000 kw.-hr., representing a 7½ per cent increase over 1926. This falls but little below the rate increase that has been experienced in recent years. During 1927 there was an approximate addition of 10 per cent in plant and equipment. The total production of electricity in 1926 was 74,000,000,000 kw.-hr., and it is expected that the figure for 1928 will show a total of 83,000,000,000 kilowatt-hours. This will be an increase of nearly 5 per cent over the 1927 figures.



What Do You Know?

BY L. H. MORRISON

The answers are on page 218

THE editor of these columns has held the belief that it was easier to answer than to ask questions. In view of the challenges made by the readers concerning a few of the answers, he is inclined to revise the statement. Nevertheless, the editorial batting average is still of major league caliber. Try your hand on the ten questions below, and if you think the editor wrong, tell him about it.

Ques. 1.—Why is the major axis of a manhole placed across rather than lengthwise of the shell of a horizontal tubular boiler?

Ques. 2.—Suppose we have a mercury column and a hollow diaphragm vacuum gage reading the same at Boston. Will the two read the same at sea level at a point on the equator?

Ques. 3.—How much heat will the average human body emit when at rest?

Ques. 4.—Why will two solid-injection oil engines having the same type of combustion device, show different mean effective pressures?

Ques. 5.—What is the purpose of having staybolts hollow?

Ques. 6.—Why do some engines use a convex and others a concave swing governor?

Ques. 7.—What kind of boiler-feed pump would you recommend to use steam expansively?

Ques. 8.—If in a two-cycle semi-Diesel the bridges at the exhaust parts show bright, to what would you ascribe it and what would you do?

Ques. 9.—What is meant by the quality of steam?

Ques. 10.—When was the first Chicago Power Show held?

PROPER CRUSHING OF COAL is important in any program toward improving boiler room operation. Experience has shown that, incidentally, it is responsible for reducing the labor turnover when trying to develop a grade of fireman who can handle the fires to meet sudden demands for steam while holding the proper air supply for the amount of coal burned.

How to Avoid Failure in Monolithic Furnace Linings

Résumé of practical experience telling why the same materials cannot be used for furnace linings and baffles, the importance of thoroughly mixing and proportioning the refractory and bonding material, with comments on compacting, drying and the use of wooden forms and reinforcing metal.

By J. L. Cummings

Manager of Refractory Department, S. Obermayer Company, Chicago

IT IS a common occurrence for a furnace user who has had excellent results from monolithic linings in his fireboxes, to install baffles of the same material in other parts of the boiler, expecting to get the same long life and freedom from cracking and spalling that he has had from a well built plastic furnace lining. When the results are not forthcoming, the inexperienced user generally blames the material, not knowing that a plastic firebrick suitable for firebox installation is unsuited for baffles, just as a plastic intended for baffles could not be expected to produce results in a furnace lining.

The reason is that the two materials are essentially different. Since baffles operate at considerably lower temperatures than are encountered in the furnace, their composition must consist of a granulated refractory material held together by a mechanical bonding agent. Firebrick plastics on the other hand, being subjected to much higher temperatures, must consist of a granulated refractory material held together by vitrification which unites the material into a solid monolithic mass. Only sufficient mechanical binder is used in a plastic firebrick to hold the material together until it can be vitrified. If more than that is used, the heat resisting and wearing qualities of the material are lowered so much that it is not suitable for the furnace, although it may be good enough for baffles, where temperature never reaches the vitrification point.

Plastics Suitable for Furnace Lining Do Not Make Good Baffles

It is clear, therefore, that if used for baffles, plastic firebrick refractories are practically certain to fail for the reason that the temperature of the gases at the baffles never becomes high enough to complete vitrification. It must be borne in mind that a plastic furnace lining material requires temperatures of from 1,000 to 1,200 deg. F. to complete vitrification and thus attain full strength.

Once the material has been properly installed, completely dried out and then fired under the temperatures given, it has great strength and offers high resistance to heat and flame abrasion. Installed in a baffle, however, in a part of the boiler where temperatures seldom reach 600 to 800 deg., the material simply dries out, vitrification is never effected, and the result is that it shortly disintegrates, leaving the user to wonder why he had such good results in the furnace and such poor results in the baffles.

No matter how good a plastic is, unless it is dried out properly and held at vitrification temperature long enough to develop its full resistance to wear and heat, it will not have sufficient strength to resist disintegration, much less

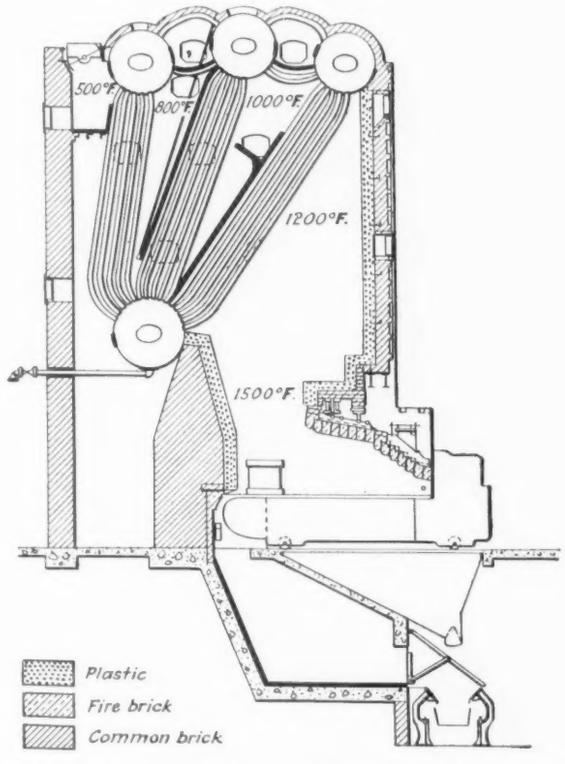


Fig. 1—This diagram shows differences of temperatures on baffles and furnace walls, and kinds of materials used

to withstand the attacks of mechanical soot blowers. The remedy, therefore, is the use of other refractory materials with a proper mechanical binder in those parts of the furnace, such as smoke boxes, baffles, and walls, where the temperatures are below 1,000 degrees.

A plastic refractory of a character used for monolithic

linings consists of inert refractory material held together by a bonding agent which serves the purpose, first, of giving plasticity while the material is wet, and second, of holding the material in place while it is being dried out. When temperatures above the vitrifying point have been reached, the refractory material and the bonding agent are welded together into a solid mass. Satisfactory

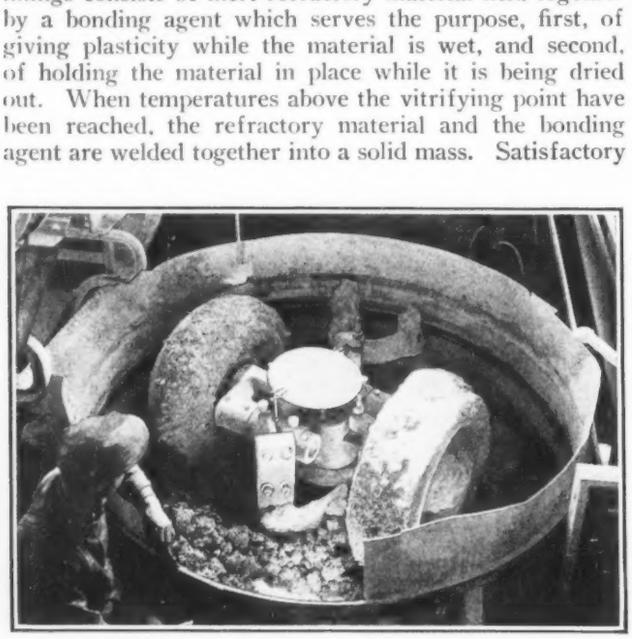


Fig. 2—Mullers consisting of wheels weighing several hundred pounds are used to mix the materials

bonding agents for vitrification generally have no great mechanical strength nor any great resistance to heat and abrasion. Since the refractory material has no mechanical bonding strength at all, the purpose, therefore, of the bonding agent is that of holding the refractory material together until vitrification has been effected.

Refractory Material and Bonding Agent Must Be Thoroughly Mixed and Exactly Proportioned

With these points clearly in mind, it will be seen that three fundamental steps are necessary in every case where plastic refractories are used. The first of these requirements is that the bonding agent and the refractory material be mixed thoroughly and exactly proportioned to give the best results. Some success has been had by the use of ground-up firebrick mixed with high-temperature cements. Difficulty with this more or less popular home-made material is that of getting the correct proportion of bonding agent and refractory material. The adjustment of these two ingredients is delicate if a good wearing refractory is to be had, since the nature of each different batch of old firebrick, and perhaps even any two brick taken from the same batch, will vary. Without careful chemical analysis it is almost impossible to get the mixture of high-temperature cement and ground-up firebrick that will produce good results.

Different degrees of oxidation encountered by firebrick while in service and changes in its chemical composition brought about by different fuels, cause wide variation among different brick and even within different parts of the same brick. The secret of good plastic refractory is accurately balanced ingredients. As pointed out, the material consists of a bonding agent and a refractory material. Unless the expansion ratios of these two materials are balanced at all temperatures, uniform expansion of the monolithic structure will not be obtained, and spalling, cracking and disintegration will follow. Careful manufacturers for this reason go to great lengths to assemble materials from various parts of the country in order to get a balanced mixture and also add a third or neutralizing ingredient to make more certain that expansion ratios are uniform at all temperatures. The better-grade plastic consists of virgin materials for the reason that their nature can be controlled exactly, so that results are certain.

Whether the material used is made of old firebrick and high-temperature cement, or is a first-class plastic, its quality will depend to a certain extent on how thoroughly the mixing has been done as well as the chemical composition. In the case of home-made plastics it is a problem, since by hand methods alone and without expensive machinery for mixing, it is almost impossible to make a satisfactory mixture. Attempts have been made to use concrete mixers, but if the material is kept stiff enough for best results, it will not be mixed, but will ball up in the mixer. The most satisfactory method is by means of mullers that eliminate the possibility of grinding or pulverizing the material, since pulverization of the refractory during mixing must be guarded against.

One of the commonest causes for failures of home-made plastics made from old firebrick is the fact that the old brick have a tendency to pulverize too finely. Too many fine particles in the filler destroy the mechanical strength. What is wanted is an evenly graded material free from dust and a material with a uniform

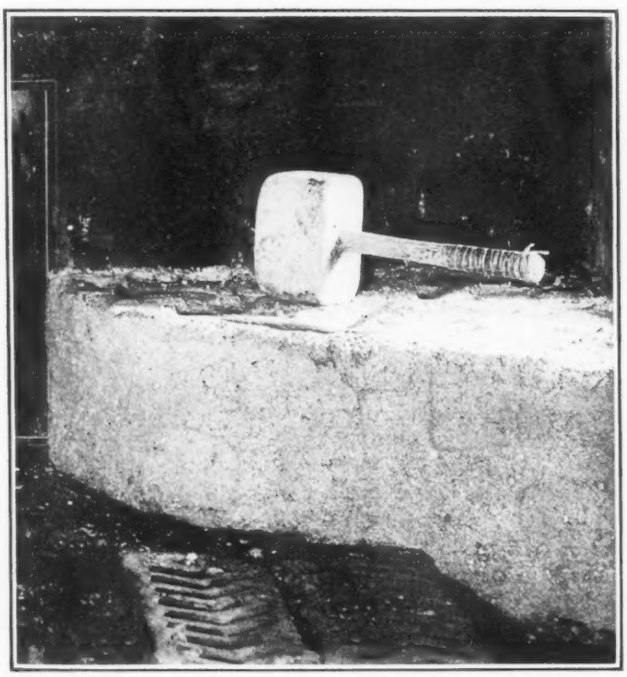


Fig. 3—A seven-pound hammer is used to pound the plastic lining until the material is thoroughly knitted

hardness. If results are to be expected that will begin to compare with a plastic made from new material, care must be exercised to select brick that are uniformly hard and to pulverize and screen so that the particles are evenly graded and uniform.

The second point to be considered is that when the

material is installed, it must be compacted solidly. If the moisture content is right, the material will compact easily under the blows of a 7-lb. mallet. Care must be taken however, that it is packed in place tightly, for the denser it is made the stronger it will be and the longer will be its life. Care should be taken not to install the material in chunks so large that extremely vigorous pounding is necessary to form them in place. Such hard pounding is likely to distort previously laid-up walls, making bulges or separations inside the wall that later will cause spalling and disintegration. It is best policy to use chunks of not more than three or four inches thickness, so that pounding need not be too vigorous.

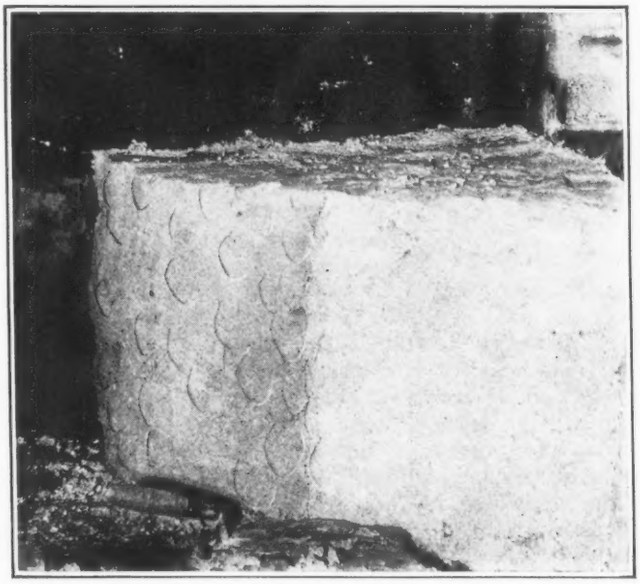


Fig. 4—Exposed surface of completed wall section is shaved with a trowel to permit the escape of moisture

Linings Should Be Dried Out With a Slow Fire to Remove the Moisture

Proper drying out is the third point to be watched. To give the bonding agent the strength to hold the material in place while it is vitrifying, most of the moisture must be removed. It is possible to air-dry a lining, but this method has serious disadvantages. In the first place several weeks are necessary if the drying is to be complete and thorough. Again, air-dried plastic refractory shows more tendency to crack and warp during drying than a plastic that is dried more quickly by means of warm air. The best method is to use a light fire in the boiler, that is sufficient to drive out the moisture, but still is not hot enough to cause generation of steam or vitrification of any part of the lining before drying out is complete.

If the fire is too rapid, there is a tendency toward the generation of steam in the material. This will disrupt the grain and loosen it up, until after a short time the material will spall and fall away even though it has vitrified until it is hard. For that reason care should be taken that the drying-out heat is never so high as to cause generation of steam. In this connection another point that must be watched is the density of the surface of the material. Where it has been densely compacted by pounding, the surface is so tightly packed that it is almost airtight, and unless this densely packed layer is shaved off with a trowel, so that moisture can escape freely, the result will be practically the same as if too much fire had been applied before the material was dry. The confined moisture will turn to steam and loosen the grain, and the plastic will spall.

A good rule for the length of time required to dry, is to allow one hour per inch of thickness. Thus if the maximum thickness of a furnace lining is eight inches, a light fire should be thrown in the firebox and banked down so that the heat will be held at drying temperature for eight hours. After that a full fire may be thrown in and the boiler put on the line. In the case of new work, however, where the plastic is built up against new, undried brickwork, a much longer time must be allowed, since the green brickwork prevents the escape of moisture on the one side and materially slows down the rate of drying.

Wooden Forms and Reinforcing Metal

A few things about forms should be borne in mind. The purpose of a form is simply to hold the plastic material in place in arches or other non-supporting shapes until it has dried out. After it is once dried, the strength of the bonding agent should be sufficient to hold it in place until it is vitrified. Metal forms are not advisable because they prevent the escape of moisture. Wooden forms are best, since they need not be removed and may be left to burn away when the full fire is thrown into the furnace.

In some instances it is a problem to keep the wooden forms from burning away during the drying period. In such a case it is a good idea to paint the wooden forms with a solution of one part water glass and two parts water. This will partly fireproof the forms and prevent them from burning during the drying-out process.

Another point about which there is considerable confusion is the matter of reinforcement. As a rule a good plastic refractory has plenty of strength without recourse to reinforcing metal. If the plastic has been prepared from accurately graded, carefully selected material, it will have ample strength. Feeling the need for some reinforcement, it has been common practice in some plants to place reinforcing rods in the arch in much the same manner that reinforcing metal is used in concrete work. This can lead to serious difficulties, owing to the difference of expansion rate of the refractory material and the metal, and in many instances reinforcing rods in an arch have broken the arch or caused spalling in the center from buckling when the metal expands more than the refractory.

For that reason it is almost necessary, whenever metal reinforcements must be used, to coat them with a layer of paper that will burn away and allow slip space between the metal and the refractory. For the same reason anchors should be coated with a layer of paper before the plastic is applied. Many cases of spalling are traceable to the failure to make such provisions.

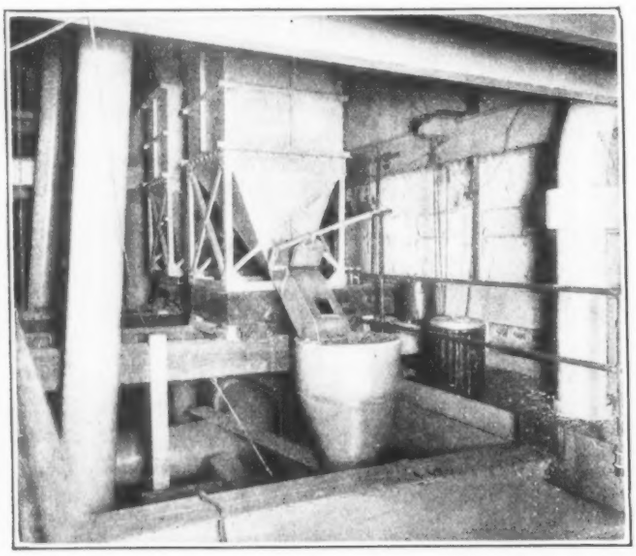
It is well to remember that plastic materials have no direct bonding power with brick or other parts of the boiler, so that adequate mechanical support must be provided for walls. The plastic wall must be made thick enough so that it is inherently stable and does not depend on other parts of the structure for support.

Unit Mill Fired Boilers *at* Cahokia Station

By E. H. TENNEY*

Using two 15,000-pound mills per boiler of 18,010 square feet, sustained boiler ratings up to 400 per cent are possible, efficiencies at all ratings are good, slagging in ashpit has been eliminated and mills so far have proved entirely dependable.

IN THE latest extension to the Cahokia Station, St. Louis, the three 18,000-sq.ft. boilers installed have been designed for, and are equipped with, unit mills and horizontal turbulent-type burners. These boilers have been in continuous operation for three months, during which time evaporative tests have been made at various ratings and sufficient operating experience gained to warrant the issuance of this statement in reply to the many requests received as to the initial performance of this equipment.

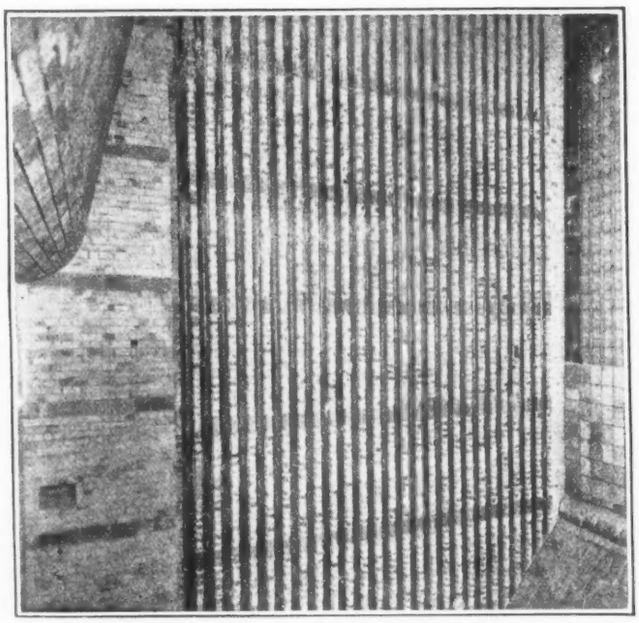


Coal-weighing equipment for boiler test

During this period of operation it has been demonstrated that sustained boiler ratings up to 400 per cent are possible, that over-all boiler efficiencies equal to or better than any heretofore obtained in the station are had at all ratings, that slagging in the ashpit, which was extremely bad on the older vertically fired boilers, is almost wholly absent, and that the unit mills are performing substantially in accordance with the manufacturers' guarantee and have proved entirely dependable.

Improvement in slagging conditions is accounted for by the fact that the hot zone of the furnace is no longer immediately above or in the ashpit, as in the earlier installations, but higher up toward the center of the furnace, where the heat is dissipated to the side-wall heating surfaces rather than to the ash in the ashpit. The floors of these furnaces are water cooled, but screens have been omitted and are not needed.

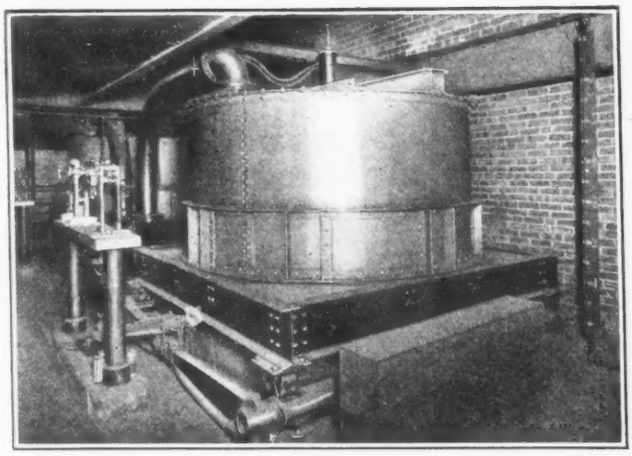
Two unit mills serve each boiler, each mill being of sufficient capacity to operate the boiler at 275 per cent rating. A wide range of pulverization is possible through the adjustment of clearances within the mills, but more extended observations and experiment along the lines of most favorable grinds for various boiler ratings will be required before the most favorable operating point for the mills can be definitely established. Up to this time the indications are that excellent furnace conditions are obtained with a maximum fineness of grind of 65 per cent through 200 mesh and 1¼ per cent as a maximum remaining on the 40-mesh.



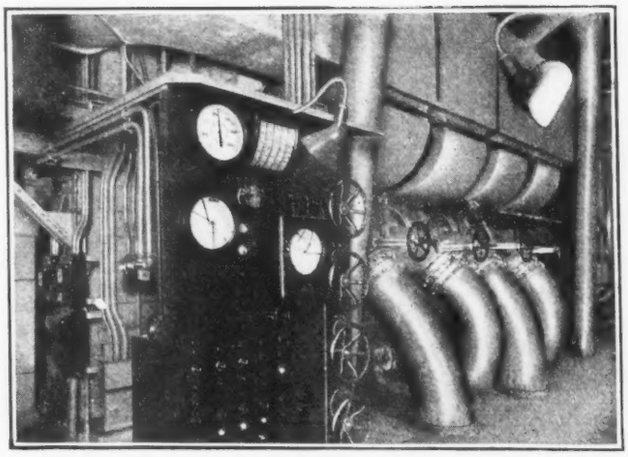
Typical side-wall view showing recessed tile construction for water-cooled wall

A cross-section of the boiler on which the tests here reported were run is shown on page 182, and the data of the principal equipment in Table I.

*Chief engineer of power plants, Union Electric Light & Power Company, St. Louis, Mo.



Water measuring apparatus as arranged for the boiler test



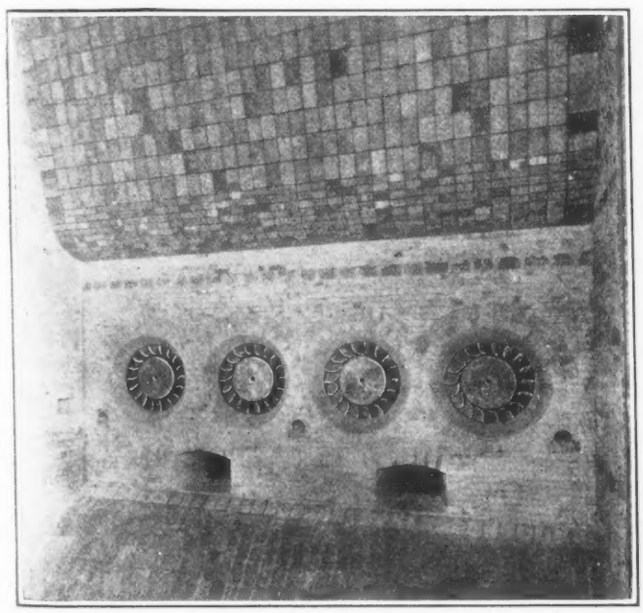
Boiler operating board and controls located on firing floor at burner level

The furnace design is the result of 3½ years' experience in the development of pulverized-fuel-fired boilers, and a word relative to this development may be of interest. The older boilers in Cahokia Station are equipped with burners that throw the powdered coal vertically downward into the furnace. These furnaces have 6.5 cu.ft. of combustion space per 10 sq.ft. of boiler heating surface, and have water screens over the ashpit and up the rear wall, giving 39.5 per cent of exposed water-cooled surface in the furnace. With this design and burning Illinois coal with an ash-fusing temperature of 2,010 deg. F., a heat liberation of 14,000 B.t.u. per cu.ft. an hour, with 33 per cent excess air, has been the maximum obtained in regular operation. Several of the older furnaces later were equipped with fin-tube side walls and have 61.1 per cent of exposed water-cooled surface, with a heat liberation of 17,000 B.t.u.

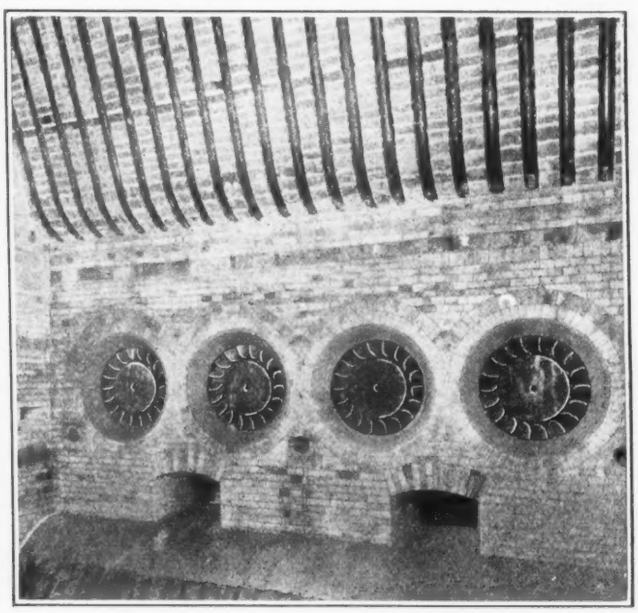
At about this stage in the development several 5,580-sq.ft. boilers at Ashley Street Station were converted to direct firing with horizontal turbulent-type burners and water-cooled block-covered walls. The furnace ratios are slightly lower than at Cahokia (5.02 cu.ft. per 10 sq.ft. of heating surface) and there is 71 per cent of exposed water-cooled surface. They develop a heat liberation of 23,000 B.t.u. per cu.ft. per hour with 30 per cent excess air; operate continuously at 325 per cent rated capacity and at efficiencies far above those ever obtained with the old underfeed stoker arrangement.

Experience at Ashley Street station, along with the results on an experimental unit-mill installation on one of the fin-tube furnaces at Cahokia Station, indicated clearly that there was a chance for improvement in the performance and costs, both investment and operating, of the Cahokia units, if served by a direct-fired system similar to that installed at the Ashley Street Plant. The three new boilers installed at Cahokia in the summer of 1927, therefore, were equipped along these lines.

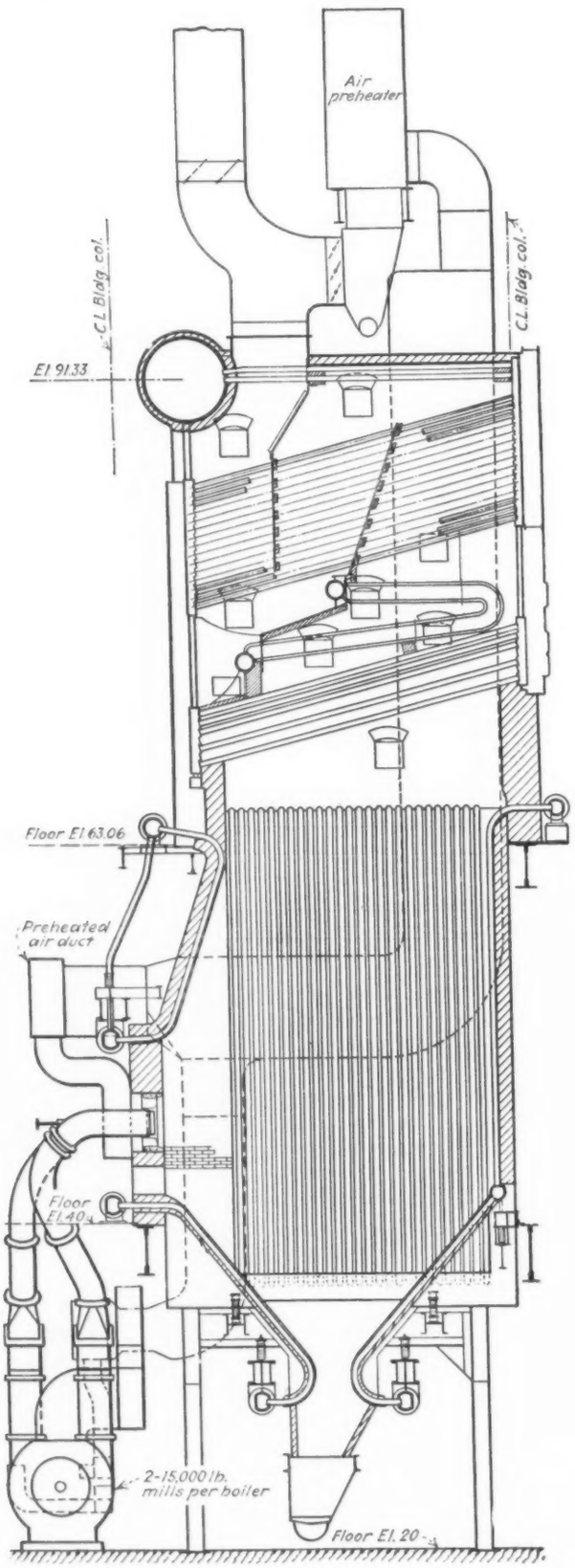
In these boilers the water-cooled furnaces have been



Front wall of No. 20 boiler equipped with Bailey blocks on front wall and on furnace bottom



Furnace of boiler No. 17 with recessed tile on front wall and water-cooled floor "cast on" block type



Sectional elevation through boiler and furnace

TABLE I—PRINCIPAL EQUIPMENT IN THREE-BOILER ADDITION TO CAHOKIA STATION

Boilers, 3, cross-drum, 18,010 sq.ft.	Babcock & Wilcox Co.
Superheaters, convection type, 3,789 sq.ft.	
Furnace, 12,400 cu.ft. combustion space; recessed tubes on side and rear walls; Furnace Engineering Company's furnace bottom and arch.	
Side walls, projected area, sq.ft.	465
Rear wall, projected area, sq.ft.	238
Ashpit floor, sq.ft.	479
Water arch, sq.ft.	93
Total surface in furnace, sq.ft.	1,275
Unit pulverizers, Simplex, 2 per boiler, 15,000 lb. per hr. each, using 4-in. white iron paddles	Furnace Engineering Co., Inc.
Burners, 18-in., 4 per boiler	Forced-draft Bailey-Tenney
Air preheater, 9,920 sq.ft.	B. F. Sturtevant Co.
Induced-draft fan, one multivane, 180,000 cu.ft. per min.	B. F. Sturtevant Co.
Forced-draft fans, two Turbovane, each 32,500 cu.ft. per min.	B. F. Sturtevant Co.

TABLE II—SUMMARY OF TEST RUNS WITH UNIT MILLS AT CAHOKIA STATION ON BOILER NO. 17

	1		2		3	
General:						
Run No.	1		2		3	
Date	12/30/27		1/3/28		1/10/28	
Duration, hours	24		24		24	
Kind of coal	West Kentucky Screenings					
Pressure and Drafts:						
Steam press., abs., lb. per sq.in.	328		335		344	
Barometric press., in. hg	29.63		30.20		29.65	
Draft in burner, in water	1.78		2.25		2.85	
Draft preheated secondary, air at burner, in water	0.77		0.94		2.27	
Draft in furnace, in water	0.038		0.045		0.062	
Draft, boiler uptake, in water	0.28		0.91		1.97	
Draft loss through air preheater, in water	0.15		0.73		3.41	
Temperatures:						
Total temp. of steam, deg. F.	685		709		729	
Superheat	259		281		299	
Temp. of feed water, deg. F.	188.0		189.4		195.0	
Temp. of flue-gas, boiler outlet, deg. F.	463		511		562	
Temp. flue-gas from preheater, deg. F.	287		375		457	
Temp. air from preheater, deg. F.	205		263		264	
Firing Data:						
Gas analysis, per cent by vol., top 3rd pass						
Carbon dioxide	16.1		15.5		14.6	
Carbon monoxide	0.0		0.0		0.0	
Oxygen	2.5		2.8		3.3	
Nitrogen	81.4		81.7		82.1	
Proximate Analysis:						
Volatile, per cent	35.46		35.21		35.73	
Fixed carbon, per cent	43.50		43.65		42.78	
Ash, per cent	15.60		15.02		15.52	
Moisture, per cent	5.44		6.12		5.97	
Heat value per lb. as fired, B.t.u.	11,722		11,562		11,598	
Average Fineness:						
Mill	A	B	A	B	A	B
Per cent through 40-mesh	99.5	99.3	98.8	98.0	94.5	96.6
Per cent through 60-mesh	97.5	97.2	94.4	94.5	86.1	89.6
Per cent through 100-mesh	92.6	91.6	85.4	86.0	74.9	76.5
Per cent through 150-mesh	88.2	86.4	78.7	78.0	66.9	65.2
Per cent through 200-mesh	80.7	77.2	70.4	70.1	58.8	54.0
Hourly Quantities:						
Steam evaporated, lb. per hr.	83,078		139,036		190,343	
Coal burned, lb. per hr.	9,548		16,950		25,119	
B.t.u. lib. per cu.ft. com. sp. per hr.	9,020		15,804		23,373	
Coal pulverized per mill, lb. per hr.	4,774		8,475		12,560	
Rate of capacity on mill, per cent	32		57		84	
Economies and Results:						
Per cent rating, boiler only	165		278		382	
Water evap. per lb. coal, lb.	8.701		8.203		7.578	
Efficiency of boiler with preheater, per cent	88.85		85.78		79.50	
Combustible in ash to stack, per cent	11.0		15.5		16.0	
Combustible in ash to pit, per cent	2.0		4.0		1.0	
Weighted av. comb. in ash, per cent	10.4		12.6		12.8	
Power Consumption—Kw.-Hr. per ton coal:						
Mills, including feeder motor and magnetic pulley	27.90		18.47		13.4	
Induced-draft fan	3.81		3.24		13.78	
Forced-draft fan	7.93		5.56		6.73	
Heat Balance:	B.t.u.	Per Cent	B.t.u.	Per Cent	B.t.u.	Per Cent
Heat absorbed by boiler	11,014	88.85	10,565	85.78	9,753	79.50
Loss due to moisture in coal	66	0.53	73	0.59	81	0.66
Loss due to moisture in burning H_2	420	3.39	440	3.57	511	4.16
Loss in dry, clean flue gases	532	4.29	790	6.43	984	8.02
Loss due to moisture in air	6	0.05	7	0.05	15	0.12
Loss due to incomplete comb.	0	0.00	0	0.00	0	0.00
Loss due to unconsumed carbon in refuse	301	2.43	337	2.74	353	2.88
Loss to radiation and unaccounted for	57	0.46	104	0.84	574	4.66
Total	12,396	100.00	12,316	100.00	12,271	100.00

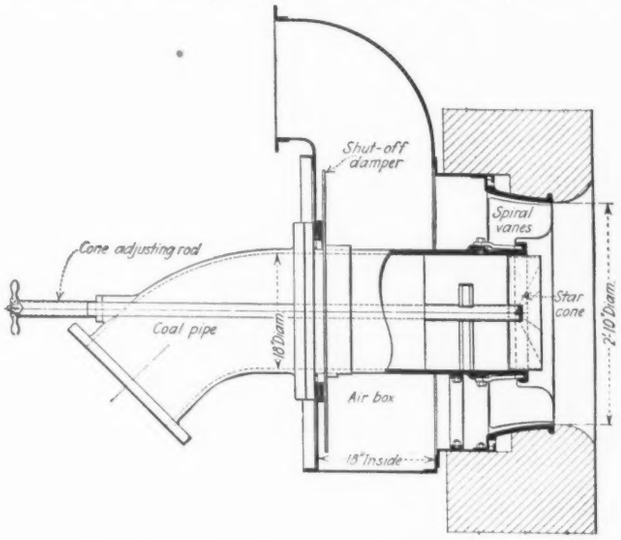
designed to maintain proper temperatures for complete heat liberation within the furnace with the zone of highest temperature far enough away from the ashpit to prevent slag at that point. The side and rear walls are bare tubes recessed into refractory, a design that has proved satisfactory in other settings at Cahokia. This arrangement does not lower the furnace temperature to the extent that bare water walls do and is somewhat less expensive than more complex designs.

Four turbulent-type 18-in. burners of the design shown in the sketch on this page, are set horizontally across the setting, with the secondary preheated air so admitted through vanes in the housing around each burner as to impart the desired turbulence.

A new design of fuel deflector is used at the burner outlet, which consists of spirally set vanes, taking the place of the solid cone deflector heretofore used. This arrangement more effectively breaks up the fuel stream and at the same time throws out the coal into the path of the swirling secondary air. The combined effect gives maximum turbulence, which results in uniformity of gas quality throughout the furnace.

A series of 24-hour tests have been run, the principal data of which are included in Table II. Although the installation was designed for Illinois coal, the plant lately has been using West Kentucky coal as a result of the recent miners' strike. The two fuels are similar except that the West Kentucky coal has a higher heat content and is lower in moisture and ash, the percentages being 8 and 14 per cent, respectively, as compared to 11 and 16 per cent for Illinois coal. The ash-fusing temperatures of the two coals are similar, being 2,010 deg. F. for the Illinois coal and 1,976 deg. F. for the Kentucky coal.

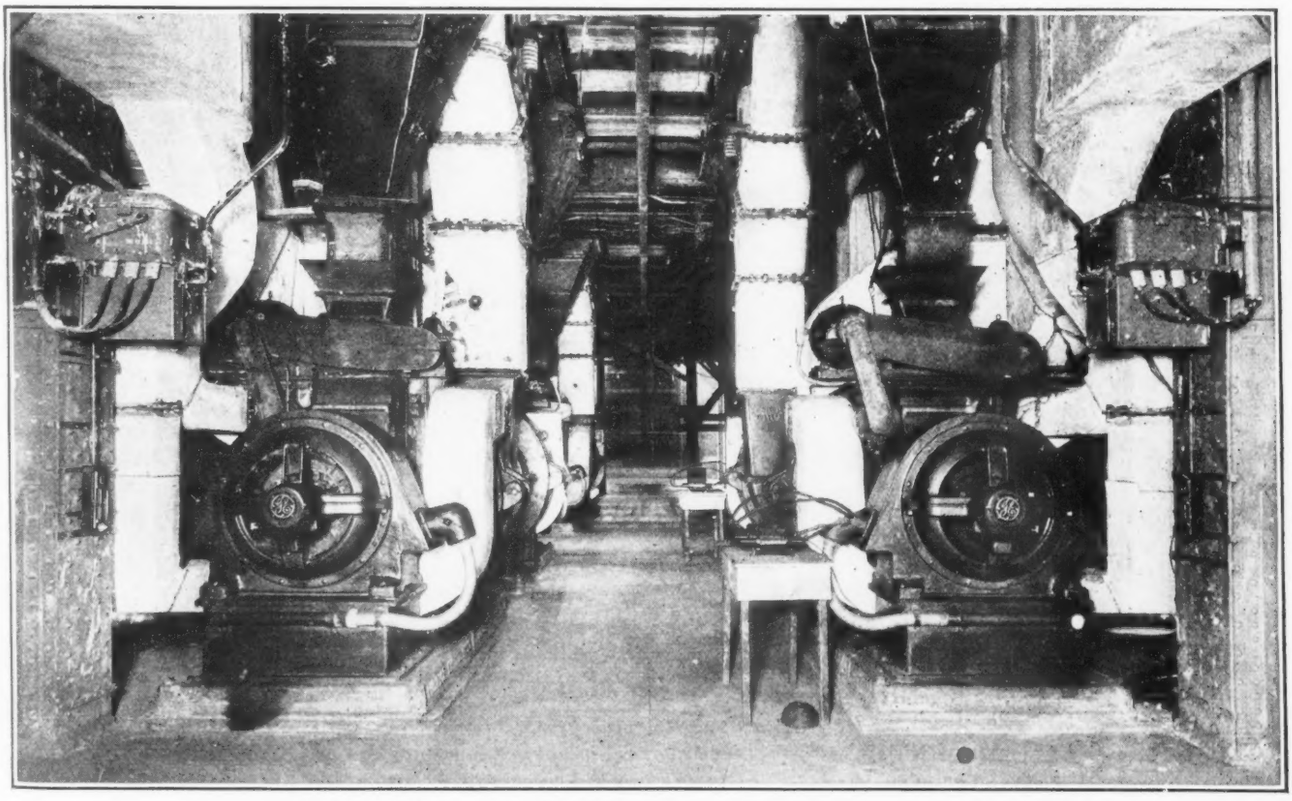
In the running of the tests all practicable precautions were taken to secure accuracy. Both coal and water were weighed on platform scales. The coal was sampled at the point of weighing, particular care being taken to



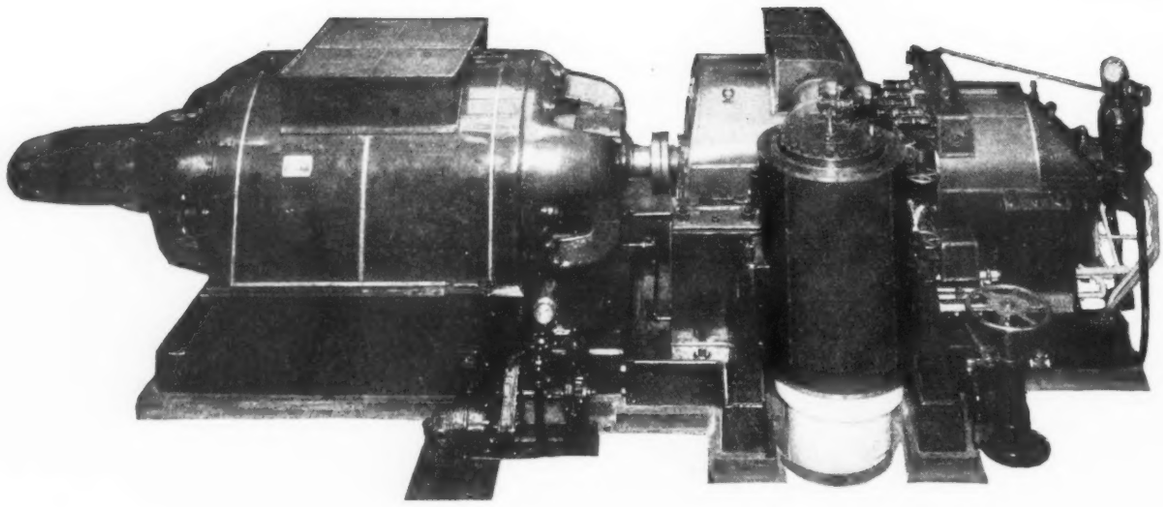
Improved design of burner used at Cahokia station

obtain accurate moisture samples. All instruments, gages, meters and scales were calibrated at the beginning and end of each test.

Simultaneous CO_2 readings taken at five points across the last pass of the boiler indicated little or no stratification of the flue gases, although the boiler was fired by two mills with two burners supplied from each mill.



Six 15,000-lb. unit mills on basement floor arranged two per boiler



Byproduct Generation *in* District Heating Plant

By J. H. Walker*

The general problem of generating byproduct electricity in a district heating plant and how it has been worked out in the Beacon Street plant of The Detroit Edison Company by means of a variable back-pressure turbine

THE idea of passing the steam through an electrical generating unit before sending it out for district heating purposes has been discussed frequently and has been practiced in varying degrees for many years. Throughout the country there are a number of combined electrical and district heating plants of moderate size in successful operation. It is thoroughly understood and appreciated that the over-all thermal efficiency of the process of generating electricity and using the exhaust steam for heating is much better than when the same amount of electricity is generated in a condensing plant, where great quantities of heat are dumped overboard, while live steam is used for heating. That the combined process has not been used universally has been due, not to lack of appreciation of the thermal principles involved, but to certain practical and commercial reasons.

To generate electricity in the heating plant there must be a considerable differential between the boiler pressure and the pressure in the heating mains. In some cities it has been found necessary to operate the district heating system at high pressure (150 lb. or more) to serve certain equipment in the consumers' buildings. Although with the present development of boilers and turbines for 400 and 600 lb. pressure, there could be, with a modern plant, a large differential, this need of "high" pressure in the distribution system has heretofore been a controlling factor in certain cases.

With the boiler pressures prevailing in the past, when electricity was to be produced, the heating mains were designed for a distribution pressure of 10 lb. gage or less. The transmission of large quantities of this low-pressure steam over long distances is difficult for two reasons: The specific volume of steam is high (20.08 cu.ft. per lb. at 5 lb. pressure, as compared with 7.78 cu.ft. per lb. at 40 lb. pressure); and the permissible pressure drop per foot of pipe is very small. It is impracticable and perhaps physically impossible to distribute, at a pressure below 10 lb., the steam output of a large modern district heating plant. The numerous large pipes required could not be laid in city streets. This has been another reason, in the past, for the use of live steam.

To transmit steam the most economical way appears to be through the use of pipes of relatively small diameter carrying steam at high velocities and with large pressure drops in the pipes. The lowest pressures preferably should not be less than 20 lb. gage. This method reduces considerably the investment costs in underground piping.

*Superintendent of Central Heating, The Detroit Edison Company.

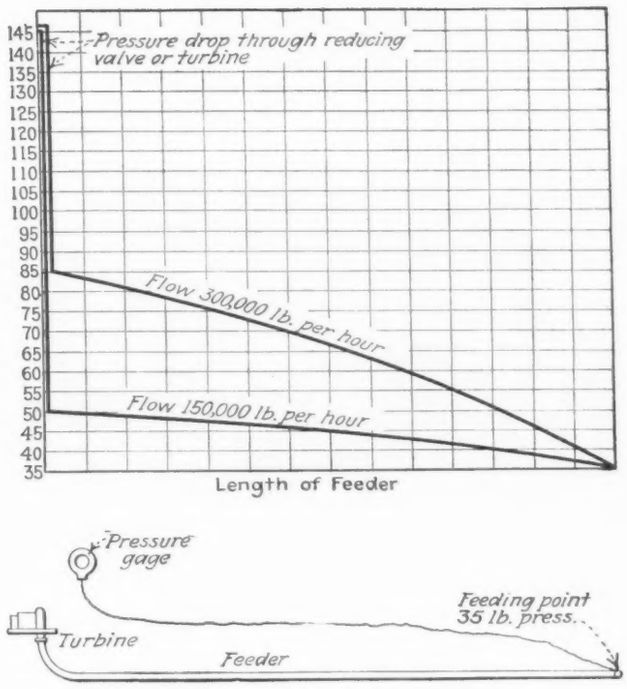


Fig. 1—Pressure drop in feeder at various rates of flow
The pressure at the remote end is held constant and the pressure at the plant is raised when a greater flow is required.

In Detroit the heating system has been developed along this line, and at Beacon Street an attempt has been made to take advantage of the possibilities of electricity generation without sacrificing the advantage, from the investment viewpoint, of using small pipe sizes.

The original Detroit heating system, installed twenty-odd years ago, was designed to distribute exhaust steam from electric generating units. Later on, the unforeseen increases in the heating load made it necessary to raise the pressure on the distribution mains and to install high-pressure feeders, which of course reduced the possibilities of power generation. To have retained the original distribution pressure of 5 lb. would have required the enlargement of many of the underground pipes.

At the present time the heating system consists of a network of service mains with feeders radiating from each boiler plant to carefully selected points in the network. In many respects the plan is similar to methods of electrical distribution. These feeder pipes are from 8 to 16 in. in diameter and carry steam at velocities of 50,000 ft. per min. and higher. The pressure on the mains themselves is in most cases about 30 lb., and a pressure of 35 lb. is maintained at the junction of the feeder with the network, while the pressure in the pipe at the plant is varied according to load conditions, so as to maintain this constant pressure at the feeding point. The feeding-point pressure is shown at the plant by an electrically operated long-distance gage.

There is always some differential between boiler pressure and feeder pressure. Ordinarily, this pressure drop occurs in a throttle valve whose opening is adjusted by hand from time to time as required. When the feeder is carrying only a small load, this pressure drop is large and it decreases as the feeder load increases. For a typical feeder this condition is illustrated in Fig. 1. The pressure drop through the throttling valve and along the feeder is shown for two different rates of flow. At a flow of 150,000 lb. per hour the differential through the throttle valve from a header pressure of 145 lb., is 95 lb., and at a flow of 300,000 lb. per hour, it is 60 lb. The amount of power that can be extracted by substituting a turbine for this throttle valve is, of course a function both of the pressure differential and of the quantity of steam flowing.

The Beacon Street Turbine

As the Beason Street heating plant is designed for a large steam output, the aggregate power that can be obtained by taking advantage of this pressure drop is sufficient to make the installation of turbines an attractive investment, although not as handsome an investment as one might suppose. Space was provided for an ultimate number of four turbines of this kind, and the first was installed in 1927. Besides exhausting into the heating-system feeder, it was desired that this turbine also should supply some exhaust steam for feed-water heating and thus correct the plant heat balance.

As indicated in Fig. 2, the turbine unit is a tandem machine consisting of two distinct turbines, one of which exhausts into the district-heating system at variable back pressure and the other exhausts into the feed-water heater at approximately atmospheric pressure. Both take their steam supply from the main header, but are otherwise entirely separate as to steam flow. Through flexible couplings they drive a 3,000-kw. alternator at 3,600 r.p.m.

The turbine exhausting into the district-heating feeder

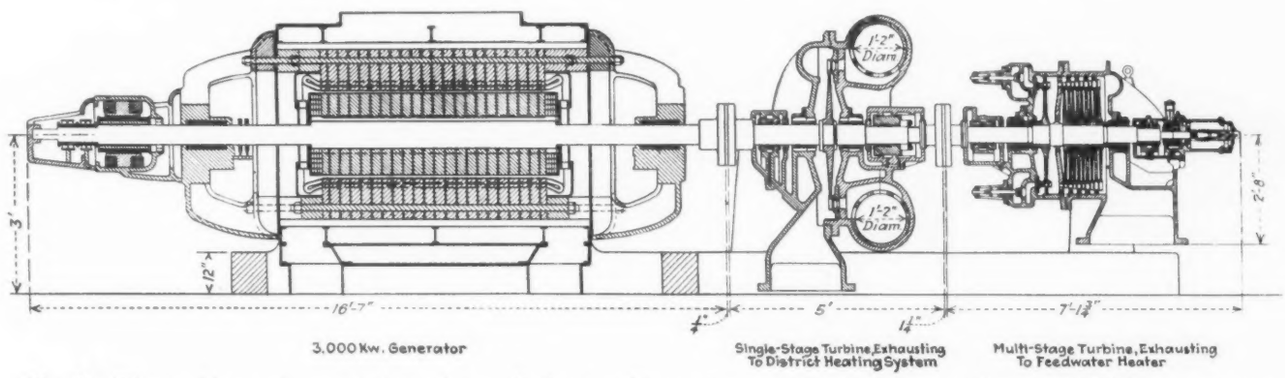


Fig. 2—The turbine unit, consisting of two distinct turbines connected by flexible couplings to 3,000-kw. generator

is a single-stage impulse machine with one row of buckets. The nozzles are arranged in groups which are controlled by a series of valves. The turbine exhausting into the feed-water heater is also a pure impulse machine having seven rows of revolving buckets. It is equipped with hand valves for nozzle control. The generator is a separately mounted machine, with direct-connected exciter, operating at 60 cycles, 4,800 volts.

Regulation of the load is effected entirely by throttling the steam supply. The constant-speed governor is used only when the machine is idling and is set for 62 cycles. The machine is synchronized by throttling and thereafter

Fig. 3 shows the performance of the single-stage turbine. The lower curve shows the relation of back pressure to steam flow, which is a characteristic of the feeder and will vary somewhat with different feeders. The upper curve shows the power developed (by the single-stage turbine only) at various rates of flow. The power output reaches a maximum as the flow is increased to 240,000 lb. per hour and decreases with further increase of flow. It is not proposed to operate the turbine when the back pressure exceeds 100 lb.; beyond this point the bypass around the turbine will be opened, but this condition will exist only for a few hours of each year after

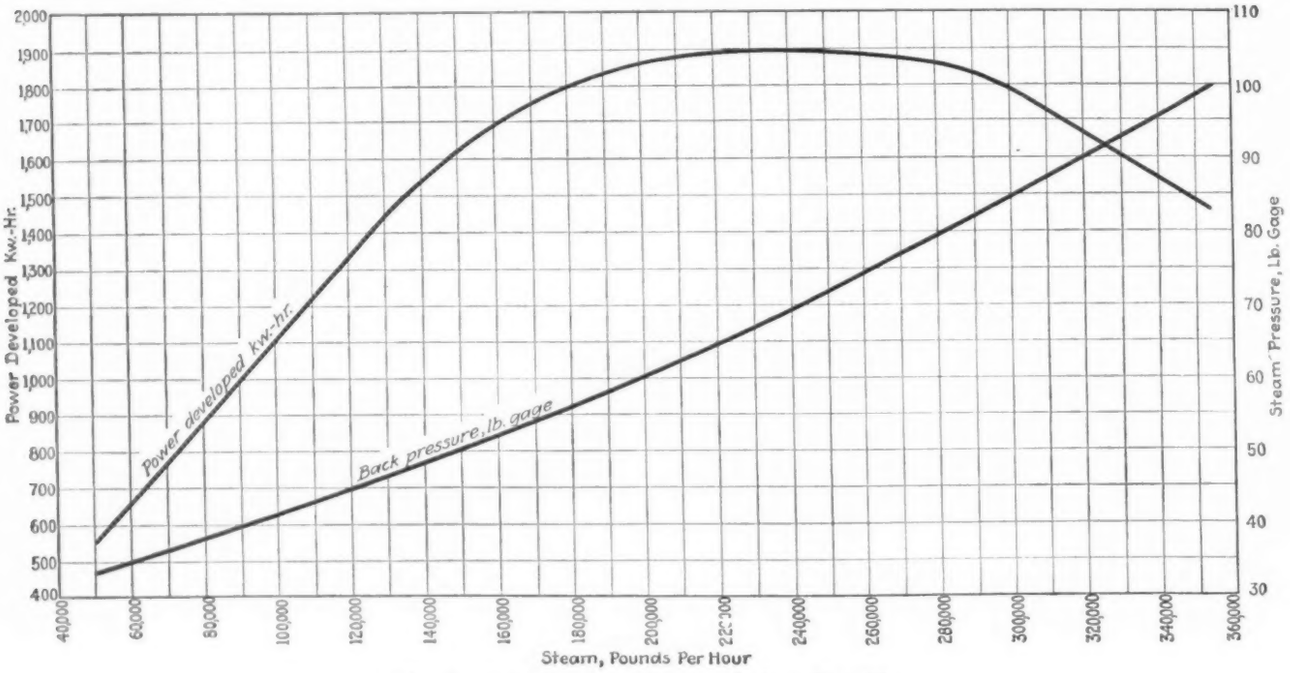


Fig. 3—Performance characteristics of turbine

The power output is maximum at steam flow of 240,000 lb. per hour

remains on throttle control. If more steam is demanded by the heating-system feeder, the operator opens more nozzle valves on the single-stage turbine and the generator takes more load. If the feed-water heater requires more steam, additional nozzles are opened on the multistage turbine. The generator output is thus regulated entirely by the steam requirements, and the electricity truly may be called a byproduct.

Characteristics

With its constant back pressure the power developed by the multistage turbine is roughly proportional to the amount of steam passing through it, but in the turbine exhausting into the feeder at a varying back pressure, this is far from being true. The energy that can be produced depends upon the pressure differential and the amount of steam flowing. The maximum power output from this single-stage machine is obtained at a flow of 240,000 lb. per hour and a back pressure of 69 lb. With increasing steam flow, the power decreases, owing to the decreasing pressure differential through the turbine. The performance of the two turbines is not in any way related. Each may develop any portion of its capacity independently of the other, up to the full capacity of the generator.

the feeder becomes fully loaded. The power output of the multistage turbine is added, of course, to that developed by the single-stage machine.

The turbine unit was designed and built by the DeLaval Steam Turbine Company, and the generator was furnished by the General Electric Company.

Obviously, this installation is a solution of an individual and peculiar problem. It permits the generation of a considerable amount of power without sacrificing the great advantage of the feeder method of steam distribution. Much greater amounts of electricity could be generated were the plant designed for a boiler pressure of, say, 400 lb. instead of 150 lb., but this was not felt advisable because of the incidental character of the electricity generation compared with the main function of the plant, which is to furnish steam for heating.

Moreover, it must be borne in mind that the low annual use factor of heating plant equipment makes it necessary to keep the first cost within bounds. Since it would manifestly be uneconomic to operate high-pressure turbines non-condensing during the summer, any installation of generating sets must pay its way during the heating season and on the day-by-day flow of steam demanded for heating. On this basis it would be difficult to justify the adoption of much higher boiler pressures.

Correct Lubrication Prolongs Life *of* Slow-Speed Engines

By E. J. Bohnen

Record made by seventeen-year-old Corliss engines proves that oil, accompanied by good supervision, is cheaper in the long run than cast iron. With a good demand for heating steam, these engines, after but little overhauling, make energy cheaper than it can be bought

JUST recently the engines in the power plant of the Standard Oil Company (Indiana) Building in Chicago were opened for inspection and measurement. It was found that reboring of the cylinders was not necessary because the largest of the three engines, in operation since 1911, was found to be only 0.003 in. out of round. The smallest engine showed a variation of slightly over 0.001 in. in cylinder diameter. Engine No. 2, intermediate in size, showed a diametral variation of about 0.002 inch.

Reboring the valve seats, fitting new rings to the pistons and making minor bearing adjustments put the engines in shape to run again for another long period of years.

When it is considered that the engines are operating at full load to 50 per cent overload most of the time, a record of no major repairs after seventeen years of service is, indeed, enviable. Such results can be accomplished only by able and strict supervision of all details. Continuous performance and minimum wear cannot be attained if lubrication is neglected.

Lubrication Practice

In these engines the cylinder oil used is a high-grade, medium-bodied, medium-compounded product. It atomizes readily when introduced into the steam line. A force-feed lubricator is used on each engine. Cylinder oil is injected in the line about six inches above the throttle. About eight drops a minute are fed to the largest engine and a correspondingly lesser amount to the smaller engines. The engine oil is a highly filtered, light-bodied product, specially fitted for a circulating system such as is used to lubricate all bearings. An efficient filter cleans up the oil, so that only small amounts of makeup are needed from time to time. About 100 gallons of cylinder oil and 55 gallons of engine oil are consumed each month. Not all of this is chargeable to the main units, because the same oils are used on the many auxiliary units.

OPERATING RECORDS FOR FIRST 10 MONTHS OF 1927

	Kw.-Hr. Total	Lb. of Steam Total	Lb. of Coal Total*	Lb. of Steam per Lb. of Coal
January	144,803	17,236,000	1,886,500	9.14
February	141,077	13,583,000	1,406,300	9.65
March	133,105	13,441,000	1,365,500	9.85
April	149,876	13,402,000	1,345,100	9.87
May	129,829	11,550,000	1,156,500	9.99
June	129,498	11,550,000	1,133,400	10.19
July	124,786	10,997,000	1,067,300	10.30
August	132,725	11,814,000	1,132,500	10.42
September	124,210	11,618,000	1,141,600	10.17
October	164,506	13,130,000	1,283,500	10.22
Average				9.97**

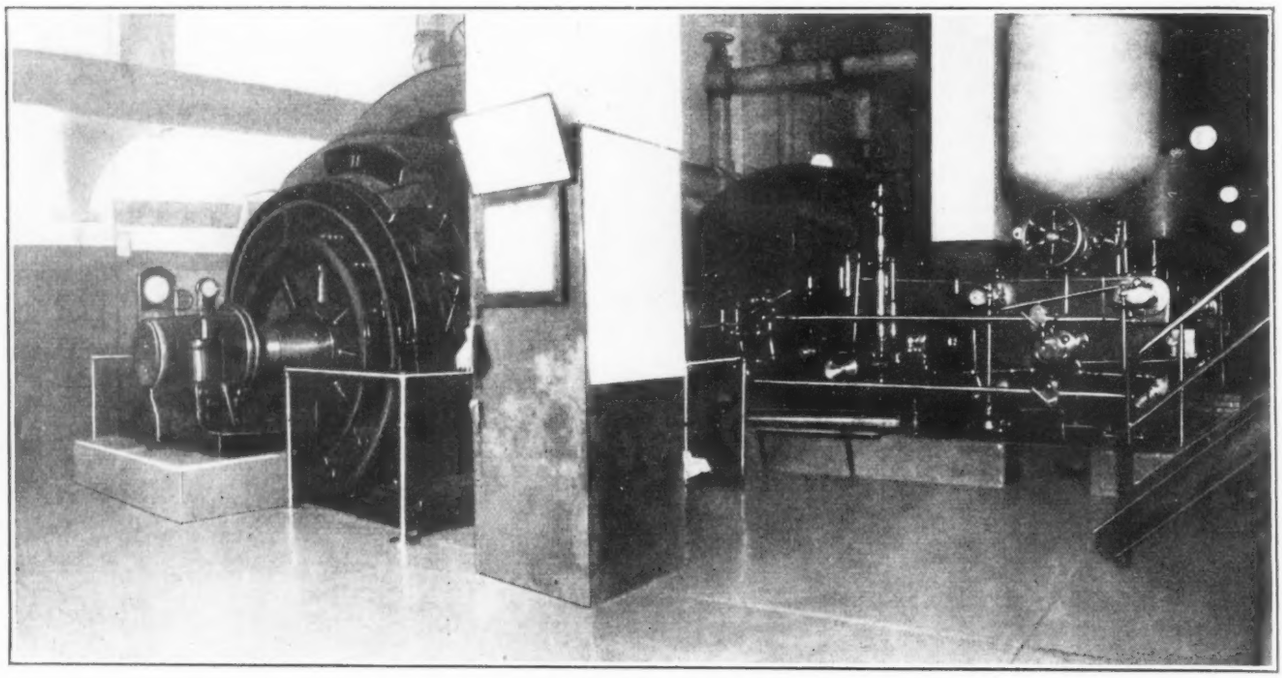
*Figures show total coal. On an average over the year about 45 per cent may be charged to the generation of electric current. Water is measured through a venturi meter and all coal is weighed.

**Such high evaporation is attained by careful treatment of the feed water to minimize scale, frequent cleaning of boiler tubes and keeping feed water temperatures at 200 deg. F. or better. Load conditions are also adjusted so that each boiler operates at an efficient rating.

When the recent addition of seven stories to the existing twelve-story Standard Oil Building was planned, the question arose as to whether it would be more economical to abandon the old plant and use central-station service, or whether it would be advisable to retain the old plant and operate it as an isolated station, as before. Careful cost records showed that the latter course would effect a considerable saving when the steam needed for heating,

labor and other items were taken into consideration. The excellent condition of the main generating units had a direct bearing on the decision.

A study of the operating figures for the first ten months of 1927, given in the table on the preceding page, may prove of interest.



Engine room with 400-kw. units in foreground

MAIN GENERATING UNITS IN PLANT

Date Installed	Engine Size, In.	Generating Capacity, Kw.	R.p.m.
1911	14x32	100	115
1911	18x32	250	115
1911	24x38	400	100
1926	24x38	400	100

Other equipment in the plant that draw upon the oil supplies are listed in the table following:

MISCELLANEOUS PLANT EQUIPMENT

Boiler feed pumps, two, direct-acting, 12x7½x12-in. American Steam Pump Company
House pumps, two, direct-acting, 10x16x9¼-in. American Steam Pump Company
Vacuum pump, one, direct-acting, 4x5x8-in. American Steam Pump Company
Vacuum pumps, two, direct-acting, 10x12x12-in. American Steam Pump Company
Hydraulic pump, one, direct-acting, 10x6x7-in. American Steam Pump Company
Fire pump, one, turbine-driven. Dayton-Dowd Company
Air compressors, locomotive type, five: Two 9¼x9½x10-in.; two 8x13x10-in.; one 9½x7½x10-in. Westinghouse Traction Brake Company
Air compressor, one, rotative, steam-driven, tandem type. Gardner Governor Company
Air compressor, one, steam-driven, for thermostatic control. American Steam Pump Company
Rotary blower, one, positive type, for ash conveying system. Connersville Blower Company

Steam is supplied by four 3,000-sq.ft. B. & W. water-tube boilers equipped with chain grates driven by an electric motor through lineshaft and belting. The engines are operated non-condensing. Exhaust steam is used for heating not only the Standard Oil Building, but also the row of office buildings on Michigan Avenue between Ninth and Eleventh Streets, and St. Mary's Church and Rectory on Wabash Avenue. Light and power are supplied also to these other buildings by the plant. The main generating units in the plant are four, releasing-type, Corliss-valve, Filer & Stowell engines driving d.c., Crocker-Wheeler generators, the size of the units and date of installation being given in the accompanying table.

Open Circuits in Armatures

THOSE familiar with faults in armatures know that if an open circuit develops in a parallel winding, it will cause a burned spot between the two segments to which the coils leads connect. In a series winding an open circuit in one coil causes a burned spot on the commutator for each pair of poles in the machine. The open circuit in the parallel winding can be closed by bridging together the two segments between which the burned spot occurs.

With the series winding bridging any one of the burned spots on the commutator will close the circuit around the open coil. Putting a bridge across each burned spot on the commutator has been tried, but this will cause heating of the winding. However, the heating is not due to short-circuiting coils in the winding, as is generally believed, but is due to placing in parallel coils that have potentials of different values generated in them.

Bridging the commutator at more than one point puts a coil in each of two adjacent slots in parallel. These coils are at different potentials, consequently a current will circulate in them. On account of their low resistance, this circulating current may reach a value that will destroy the coil's insulation. A better method of closing the open circuit is to locate the two commutator bars to which the faulty coils connects and connect these bars with a long jumper.

Waste-Heat Power *for* Modern Cement Mill

By Gordon Smith*

IN A 3,000-bbl. plant waste heat from powdered-coal fired kilns generates sufficient steam to meet power demand with condensing turbine-generators. Boilers are equipped with superheaters and economizers. Heat balance is maintained by an evaporator system arranged to use all surplus steam for the making of distilled water, which is stored for boiler feed. Hand-fired boiler and non-condensing house turbine provide power for starting or stand-by service when the kilns are shut down.

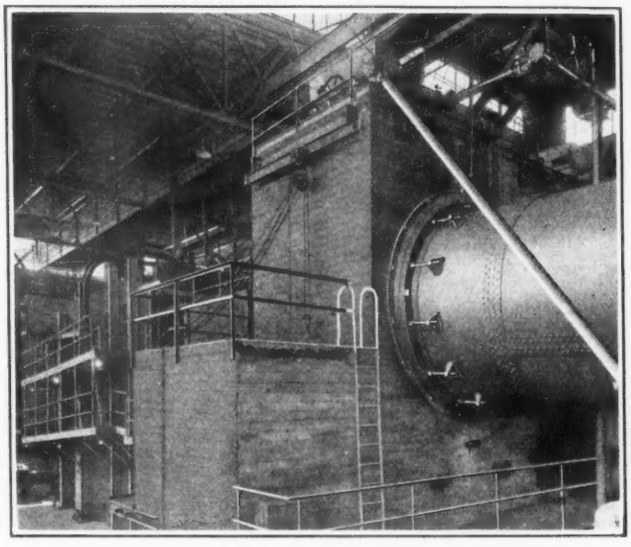
GENERATION of steam and subsequently power from the waste gases of an industrial process, is not, at this date, a novel idea, nor does an installation of boilers, flues, fans, turbines, condensers, etc., for such a purpose ordinarily excite the engineering fraternity. It is worthy of note, however, that the portland cement industry has carried many of its installations of waste-heat power equipment to a high point of efficiency and economy, so that the following description of the waste-heat power plant in a modern cement mill may profit other industries as well as the cement field.

The plant in question is that of the Dewey Portland Cement Company at Davenport, Iowa, a wet-process mill of 3,000-bbl. daily capacity, placed in operation in June, 1927. As this article is being written, plans are under way and orders placed for the installation of a third kiln and its corrolary units, for all of which room was provided in the present buildings and parts of the foundations placed. This additional equipment will bring the daily capacity up to 5,000 barrels.

In this mill, situated on the north bank of the Mississippi River, about seven miles west of Davenport, the kilns, boilers and power machinery are in one long building at right angles to the river, the turbine station comprising that section of the building nearest the river. Two lines of concrete pipe from the hot and cold wells at the turbine station out into the river channel bring in the water supply for the entire plant.

In the manufacture of portland cement the raw materials, consisting of about 75 per cent calcium carbonate (limestone), the remainder silica, alumina and iron oxides, with varying small percentages of other carbonates, sulphates and oxides, are ground to a fineness in excess of 85 per cent passing 200-mesh. Where these materials are ground in the presence of water to form a "slurry," we have the wet process. Where the materials are first dried, then ground and blended, we have the dry process. The latter is somewhat more economical of fuel, but is rapidly being displaced by the wet process, owing to better control of the raw materials and consequent better and more uniform output than is possible with the dry process.

This slurry, of the consistency of a thick soup and carrying a water content of about 33 per cent, is pumped from the grinding mills into correction and storage tanks and thence into the rotary kilns, at the rate of about



Feed end of kiln; boilers in background

900 lb. per min. The kilns are cylindrical steel shells 11 ft. in diameter and 175 ft. long, lined with firebrick and revolving at a speed of about ½ r.p.m. The axis of the kiln is inclined at a slope of ½ in. in 12 in. Each kiln is driven through suitable reduction gearing from a 75-hp. motor.

The 900 lb. of slurry fed per minute, when dried, calcined and sintered in the kiln, will be reduced to about 485 lb., the discharge rate of the kiln per minute, and sufficient "clinker" when ground to requisite fineness and with the addition of the necessary gypsum to regulate

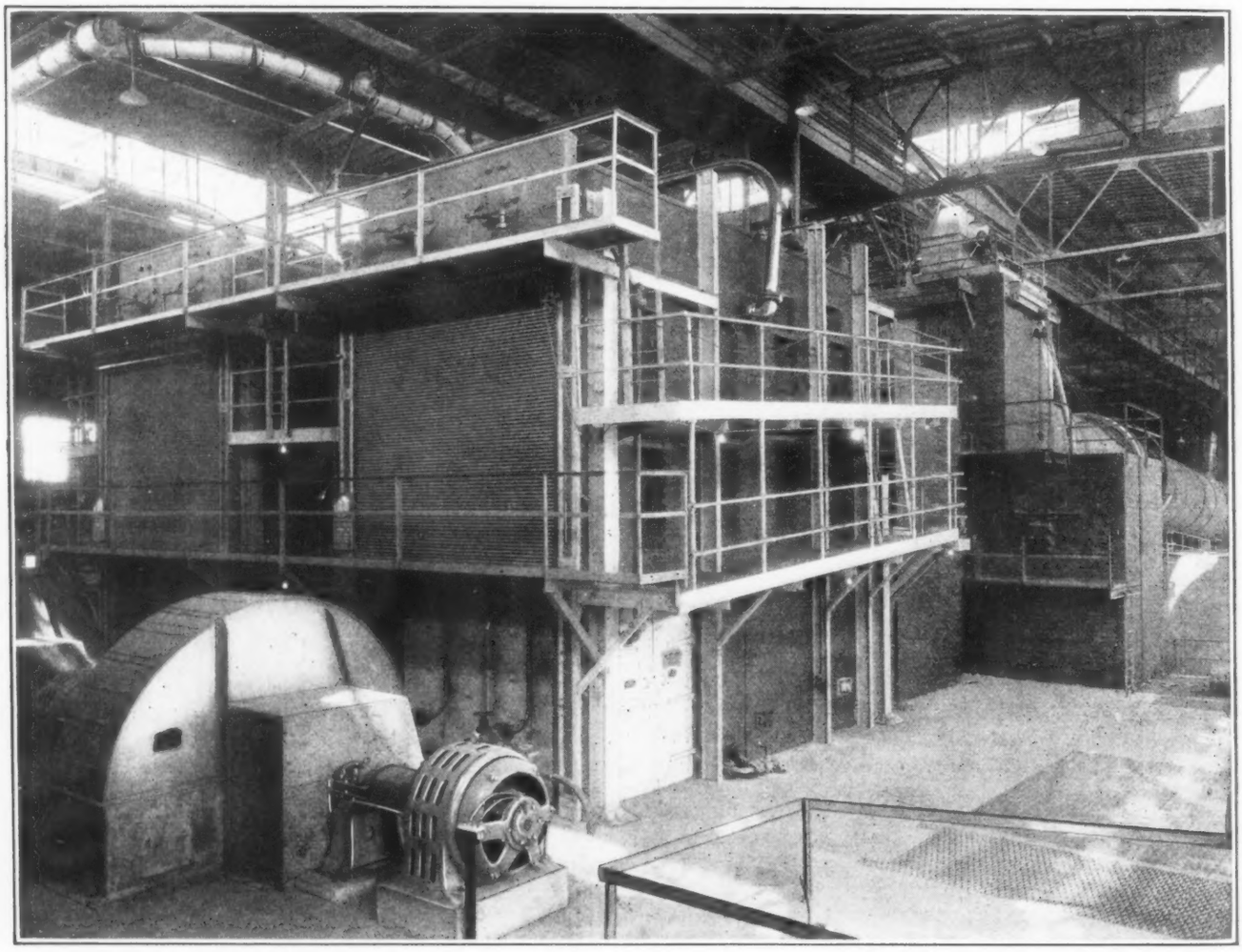
*Of J. C. Buckbee Company, consulting and designing engineers, Chicago.

the setting, to make one barrel of cement weighing 396 lb. These figures are general averages and will vary at different mills owing to variation in chemical analyses of both raw materials and finished cement.

In the kiln the first action is that of driving out the water content of the slurry; next the calcining of the limestone content of the mixture, a process that is probably complete at a temperature of about 1,500 deg. F.; then the heating of the calcined mix to a temperature of between 2,400 and 2,800 deg. F., at which point there occurs a sintering action resulting in the formation of the partly fused cement clinker. This reaction, which is a complex one between the lime, silica, alumina and iron, is generally conceded to be exothermic or one producing heat, although the amount of heat generated thereby is not a figure upon which physicists agree. The material has by now passed through the firing zone or hottest point of the kiln and is discharged into rotary coolers, and upon cooling, is ready for the final dry grinding to form that universally known and used commercial substance, portland cement.

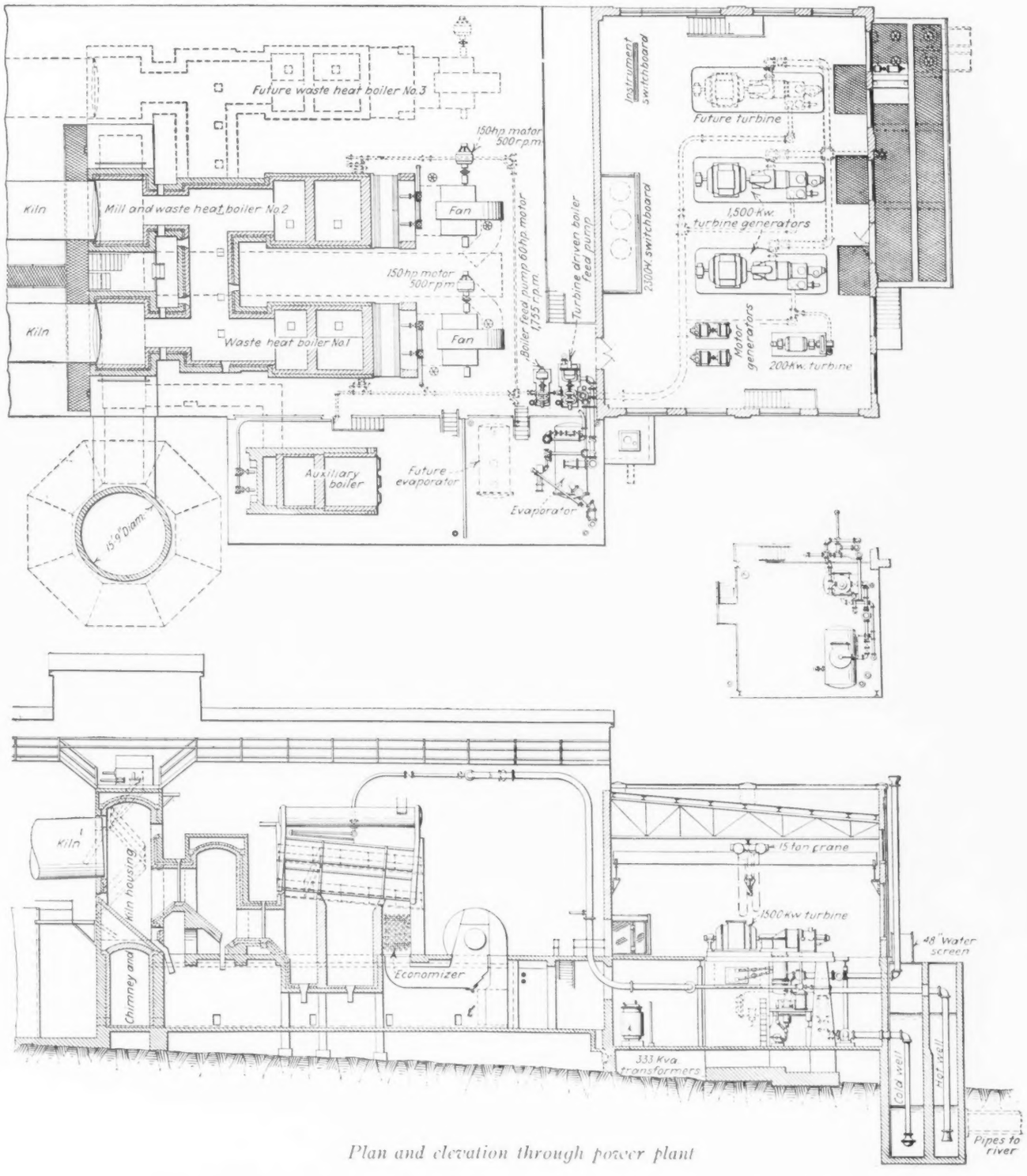
Through a hood at the lower end, the kiln is fired with powdered coal, the average consumption per barrel for well-operated wet-process kilns of the size mentioned and with slurry carrying one-third water, being about 120 lb. of 12,500-B.t.u. coal per barrel, or about 1,500,000 B.t.u. per barrel. By itself the kiln is a rather inefficient heat machine, its distribution being given by one authority as follows: Heat lost in clinker, 5 per cent; heat lost in radiation, 6 per cent; latent heat of evaporation, 20 per cent; heat carried by waste gases, 45 per cent; heat used in reactions, 24 per cent; total, 100 per cent.

The powdered coal used as fuel is prepared in much the same way as for a boiler plant installation, grinding to a fineness such that 95 per cent passes 100-mesh. In the mill under discussion the coal is received through a hopper, put through a roll crusher, thence to a bin from which it is fed to a direct-fired drier, thence to dry coal bins and ground in air separation roller mills. The coal mill is situated at a distance from the kiln room, and the pulverized fuel is transported to bins immediately behind the kiln firing hoods in an air transport system. From these bins the coal is blown into the kilns from variable-speed screw feeders. About 25 per cent of the air necessary for combustion is introduced into the kilns with the



The two waste-heat boilers with induced-draft fans in foreground and kilns in background

coal, this air being taken from around the outside of the coolers at a temperature of about 100 deg. F. The rest of the air required for combustion is drawn through the evaporation of the water content of the slurry. These gases leave the kilns at a temperature of about 1,100 deg. F., passing first into the kiln discharge chambers,



Plan and elevation through power plant

coolers over the cooling clinker and enters the kilns at a temperature of about 500 deg. F.

Gases passing the feed or cold end of the kiln comprise the products of combustion, the carbon dioxide from the calcining of the mix and the steam from the

which are 8 ft. by 11 ft. 6 in. in plan and of reinforced concrete lined with Sil-O-Cel and firebrick. The top slabs are made in removable concrete sections to permit easy access for repairs to the arches and walls.

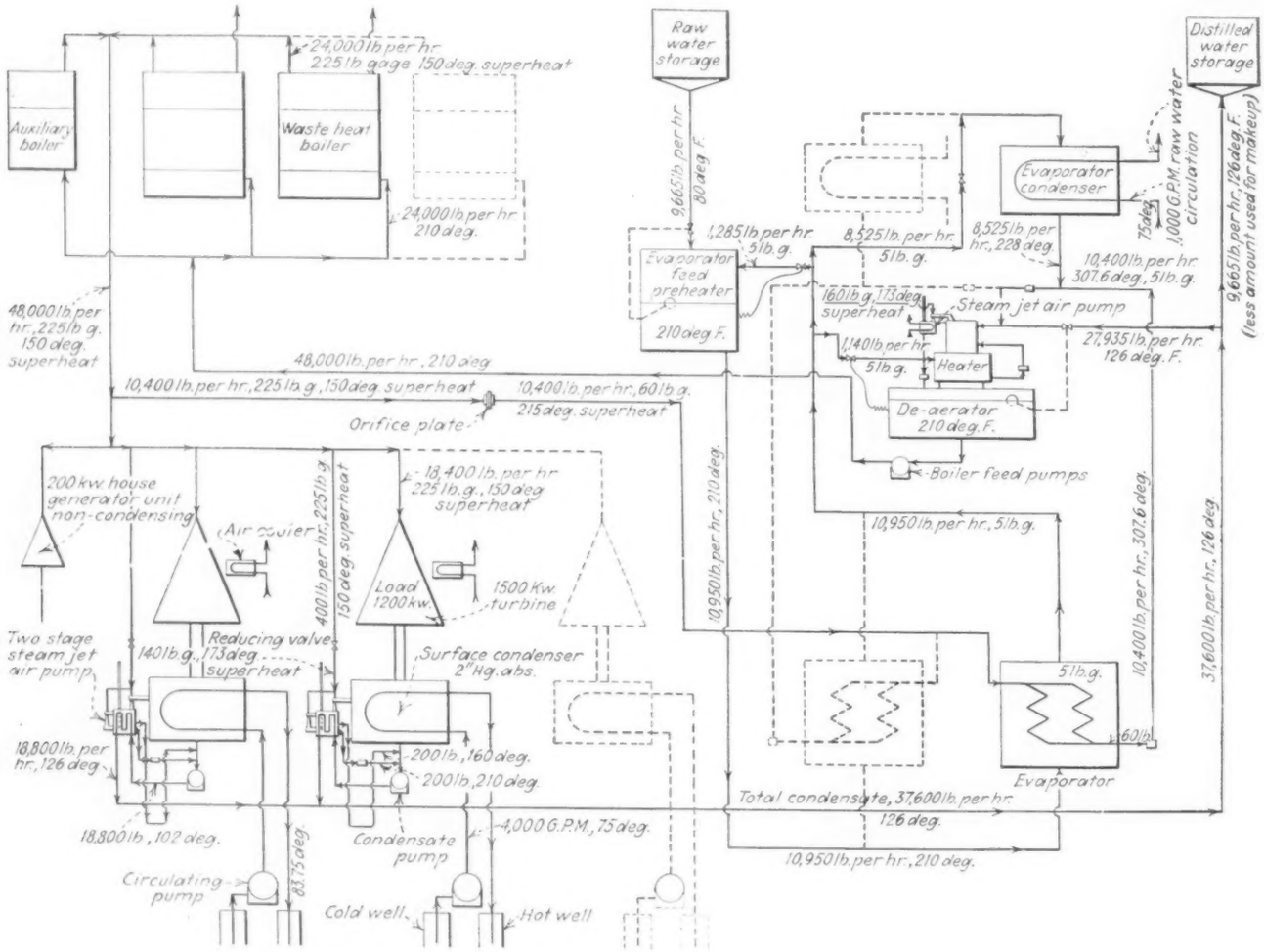
Opposite and below the opening for the mouth of the

kilns is the opening through which the gases normally pass from this chamber into the cross or equalizing flue from which the offtakes to the boilers are made. The purpose of this equalizing flue is to balance the load on the two boilers and to steady the operation should any variance develop in the kiln operation. The short flues connecting the kiln discharge chambers and the boilers to the equalizing flue are provided with dampers so that either kiln or either boiler may be taken out of service. The kiln chambers are further provided with dampers and connections for bypassing the hot gases around the boilers and direct to the stack. These flues are also of concrete lined with Sil-O-Cel and firebrick.

going gases should run about 350 deg. F. at the base of the stack, so that the over-all thermal efficiency of the kilns and boilers should be around 50 per cent, which is not unsatisfactory considering the enormous volume of the revolving kiln furnaces, the consequent radiation losses and the extent of the flue system and attendant losses from radiation and leakage.

Stand-by Boiler Provided

In a building adjoining that housing the foregoing equipment is a 4,000-sq.ft. hand-fired auxiliary boiler equipped with a superheater and directly connected to the stack flue. This boiler is for stand-by use in starting


Raw water storage
Distilled water storage
Auxiliary boiler
Waste heat boiler
24,000 lb per hr 225 lb gage 150 deg. superheat
24,000 lb per hr 210 deg.
9,665 lb per hr 80 deg F.
Evaporator condenser
1,000 G.P.M. raw water circulation
75 deg.
1,285 lb per hr 5 lb g.
8,525 lb per hr. 5 lb g.
8,525 lb per hr, 228 deg.
10,400 lb per hr 307.6 deg., 5 lb g.
Evaporator feed preheater
210 deg F.
160 lb g. 173 deg. superheat
Steam jet air pump
1,140 lb per hr 5 lb g.
Heater
27,935 lb per hr. 126 deg. F.
9,665 lb per hr, 126 deg F. (less amount used for makeup)
48,000 lb per hr, 225 lb g. 150 deg. superheat
48,000 lb per hr, 210 deg
10,400 lb per hr, 225 lb g, 150 deg superheat
10,400 lb per hr, 60 lb g. 215 deg. superheat
Orifice plate
De-aerator 210 deg. F.
Boiler feed pumps
200 kw house generator unit non-condensing
Air cooler
18,400 lb per hr 225 lb g., 150 deg superheat
400 lb per hr, 225 lb g. 150 deg superheat
Load 1200 kw.
1500 Kw. turbine
10,950 lb per hr, 210 deg.
10,950 lb per hr, 5 lb g.
10,400 lb per hr, 307.6 deg.
37,600 lb per hr, 126 deg.
Two stage steam jet air pump
140 lb g., 173 deg. superheat
Reducing valve
Surface condenser 2" Hg. abs.
5 lb g.
60 lb
18,800 lb per hr, 126 deg
200 lb, 160 deg.
200 lb, 210 deg.
Evaporator
Total condensate, 37,600 lb per hr. 126 deg.
18,800 lb, 102 deg.
Condensate pump
4,000 G.P.M., 75 deg.
83.75 deg
Circulating pump
Cold well
Hot well
10,950 lb per hr, 210 deg.

Typical heat-balance diagram for normal load indicating schematically the system operation

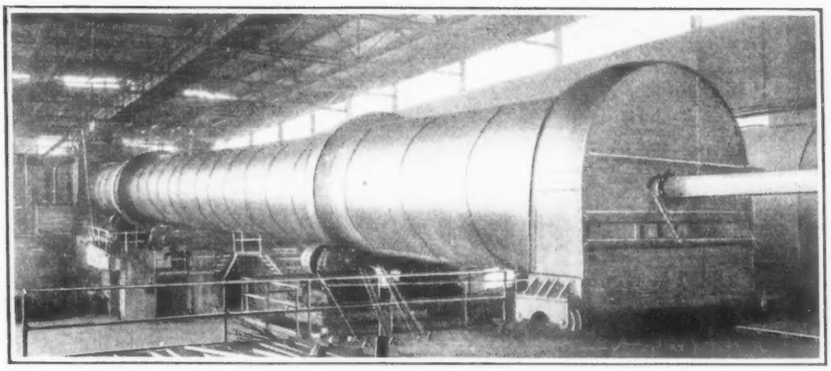
The boilers are of the horizontal, straight-tube, four-pass, double-drum type having 9,200 sq.ft. of heating surface each and equipped with superheaters and economizers. Each boiler has an induced-draft fan, directly connected to a 150-hp. variable-speed motor, that has a capacity of about 78,000 cu.ft. per min. of 380-deg. gas at $7\frac{1}{2}$ in. The fans discharge into a central flue running back, below and between the boilers to a cross-flue under the kiln chambers, which leads outside to the 12x200-ft. concrete stack.

Under normal load conditions the temperature of out-

the plant and providing steam for operation when the kilns are shut down. Of the two 3-in. four-stage centrifugal boiler feed pumps installed, one is driven by a non-condensing turbine and the other by a 60-hp. motor. The auxiliary boiler room also houses the evaporator system, to be described in more detail later.

Steam from the boilers for turbine supply is delivered at 225 lb. gage and 150 deg. F. superheat. There are two main generating units each of 1,500-kw. capacity, operating at 3,600 r.p.m., 2,300 volts and 28 in. vacuum Each unit is served by a 3,200-sq.ft. surface condenser

equipped with steam-jet air pumps having inter and after condensers. Circulating water for the condensers is supplied from a cold well by 4,000-gal. per min. motor-driven pumps. In addition to the main units there are a 200-kw. non-condensing house turbine unit, with direct-connected exciter; two motor-driven 60-kw. exciter sets and the seven-panel 2,300-volt main control switchboard. Three 333-kva. 2,300-460-volt transformers for supplying low-tension current for operation of the turbine station and boiler room auxiliaries are located below the main switchboard in the basement of the building.



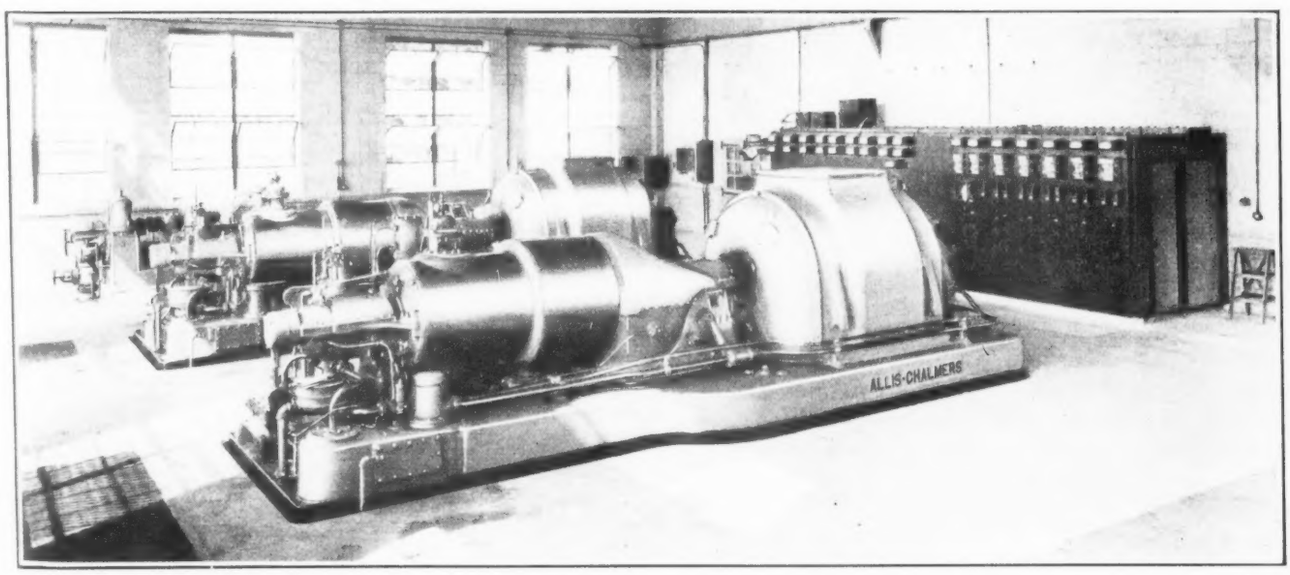
Rotary kilns from firing end, 11ft. in diameter and 175 ft. long

As previously mentioned, the hot and cold wells at the turbine station are connected to the main channel of the river through two lines of 36-in. reinforced concrete pipe laid underground. The pipe chamber of the wells is so provided with valves that either pipe may be used for the hotwell overflow, thus permitting a reversal of flow in the pipes to assist in keeping them free from river sludge and also to permit the hot water to be thrown upstream in cold weather and aid in keeping the intake clear of ice. The water supply for the plant may be taken from either hot or cold wells by two 1,000-gal. per min. motor-driven service pumps that discharge into the plant mains connected to the 35,000-gal. concrete storage tank.

Boiler feed is prepared in an evaporator system located in the auxiliary boiler room. The schematic operation of this system is shown in the heat balance diagram on the opposite page, which gives the typical normal load heat balance for the plant. The equipment is of generous proportions and arranged so that any surplus steam under reduced load conditions will be utilized in the manufacture of distilled water rather than blown off through the safety valves.

Operation of the evaporator system follows conventional lines up to the point of the evaporator condenser. At this point it will be observed that inasmuch as there is a surplus of steam when the kilns are being operated at maximum capacity, raw river water is used as the cooling medium rather than condensate, as is usually the case. This renders possible the use of all surplus steam for the making of excess distilled water, thus avoiding blowoff. The distilled water produced is stored in the top section of the water tank, having a capacity of about 35,000 gal. This storage provides ample reserve of clean pure boiler feed to meet any emergency conditions within reasonable expectations.

The design of this plant represents the accumulated experience of the engineers in charge of the work, the J. C. Buckbee Company, of Chicago, who for the last twenty years have specialized in consulting and designing engineering for the cement, crushed stone and gravel industries. The installation has been markedly successful and has fully demonstrated its flexibility, reliability, and economy in operation under varying conditions.



View in the turbine room showing the two 1,500-kw. units and the small stand-by unit in background

Coal Ash and Its Fusion

By W. D. Langtry*

CONTRARY to the usual view, the fusion temperature may increase with the percentage of ash and high sulphur content may go hand in hand with high fusion temperature, so it would seem that too much stress is being placed upon ash and sulphur as the primary causes of clinker formation.

FORMATION of clinker is the cause of more shutdowns in a boiler plant and steam failures of locomotives than almost any other one thing. There is practically no coal in the United States that is absolutely immune from the formation of clinker under certain conditions. This statement is made having in mind that the ash in coal, as it is commonly known, will fuse if a temperature is reached that is high enough to cause it to flux.

Coals in the United States will range in fusion temperature anywhere from 1,800 to 3,200 deg. F. The accumulation of clinker on grate bars has several bad effects, the most serious being the reduction of the air supply. This in turn decreases the rate of combustion and the heat generating capacity of the furnace. Clinker adds to the labor of firing, particularly when the plant is hand fired, and the cost of maintenance is increased, as the tendency is to destroy firebrick, grate bars, etc.

There is no mystery at all connected with clinker formation. The following are a few of the causes of the fluxing of coal ash:

1. A hot, intense fire, the temperature of which is above the melting point of what is commonly called ash in coal.

2. The fuel bed may be so thick that it restricts the draft so that fuel-bed temperatures are developed above the fusion temperature of the ash. As the rate of combustion increases, the likelihood of clinker formation is increased owing to the higher temperatures within the fuel bed.

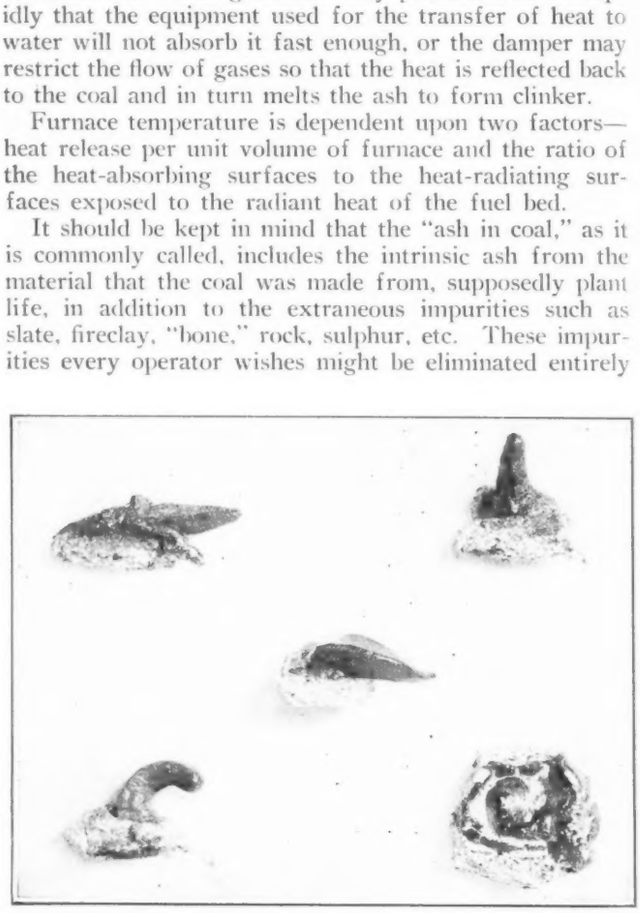
3. Foreign material, such as glass, tin cans and other refuse, when mixed with the coal ash, may cause a flux at a lower temperature than would the ash of the coal itself.

4. Too frequent stirring or puddling of the fuel bed; in other words, a fuel bed that is constantly disturbed with a poker or slice bar exposes the particles of ash to intense heat that causes the ash to fuse.

In general, the ashes of some of the best coals produced from a quality standpoint may have fusion temperatures lower than coals of poorer grade, say 2,200 to 2,300 deg. F., as compared with the ash of other coals that may not fuse even at a temperature of 3,000 deg. F. One of the most common complaints concerning clinker formation is what is commonly called a "bottled up heat condition" in which good coal may produce heat so rapidly that the equipment used for the transfer of heat to water will not absorb it fast enough, or the damper may restrict the flow of gases so that the heat is reflected back to the coal and in turn melts the ash to form clinker.

Furnace temperature is dependent upon two factors—heat release per unit volume of furnace and the ratio of the heat-absorbing surfaces to the heat-radiating surfaces exposed to the radiant heat of the fuel bed.

It should be kept in mind that the "ash in coal," as it is commonly called, includes the intrinsic ash from the material that the coal was made from, supposedly plant life, in addition to the extraneous impurities such as slate, fireclay, "bone," rock, sulphur, etc. These impurities every operator wishes might be eliminated entirely from the coal as it is produced, but this is physically impossible except at prohibitive cost.



Ash cones that have softened at the fusion temperature

When the refuse in coal is analyzed in the laboratory, it is found to be made up of the following ingredients, for which the fusion or melting temperatures are given to the nearest 50 deg.: Sicila, 3,200 deg. F.; iron oxide (ferric), 2,700 deg. F.; alumina, 3,700 deg. F.; lime, 4,650 deg. F.; magnesia, 5,050 deg. F.; soda, low red heat; potash, low red heat.

When these different materials are brought together in the form of coal ash in different percentages, it is always a question as to what the temperature will be when the fluxing takes place. The generally accepted theory for the formation of clinker is that the material

*President, Commercial Testing & Engineering Co., Chicago, Ill.

that melts first acts as a magma to collect the unfused portions of the mineral matter present. This formation gradually spreads over the grate and then hardens into a clinker as the fluxing action proceeds.

In our laboratory numerous fusion determinations of coal ash have been made in a specially designed and accurate furnace in which all temperature readings are made with an optical pyrometer. There is one phase of the results that has proved a rather interesting study. It has been more or less a common belief of both the coal producer and the purchaser that the lower the percentage of ash in coal coming from the same seam in the same mine, the higher will be the fusion temperature. In other words, if the larger sizes of coal such as nut, egg, and lump, contain less ash than screenings of the same coal, then the fusion temperature for the purer coal should be higher.

ASH FUSION TEMPERATURES FOR VARIOUS COALS

Kind of Coal	Mine	Dry Ash, Per Cent	Dry Sulphur, Per Cent	Fusion Temp., Deg. F.
2-in. screenings	A	8.66	0.61	2,412
Mine run	A	5.92	0.73	2,270
4x2 egg	A	3.67	0.70	2,223
4-in. block	A	2.84	0.64	2,270
2-in. screenings	B	6.44	0.98	2,209
Mine run	B	4.34	0.91	2,081
4x2 egg	B	2.55	0.59	1,957
4-in. block	B	1.21	0.59	1,979
1½-in. screenings	C	5.14	2.28	2,234
Mine run	C	4.30	2.06	2,012
1½-in. screenings	D	5.14	2.28	2,234
Mine run	D	4.30	2.06	1,968
Coal through 3-in. screen	E	5.54	0.65	2,656
Coal on top of 3-in. screen	E	2.50	0.60	2,492
Raw coal, 2x1-in	F	11.98	3.32	2,525
Cleaned coal, 2x1-in	F	10.89	2.99	2,510
Egg, 6x3	G	9.72	1.33	2,478
Egg, 6x3	G	8.82	1.13	2,362
Raw coal screenings	H	29.71	0.75	2,567
Cleaned coal at 1.70 sp.gr. float	H	17.93	0.87	2,234
Refuse 1.70 sp.gr. sink	H	58.76	....	2,828
Nut raw coal, 2x1	I	9.29	4.25	2,100
Clean coal at:				
1.40 sp.gr. float	I	7.48	2.93	2,034
1.50 sp.gr. float	I	16.61	8.69	2,201
1.50 sp.gr. sink	I	44.23	....	2,243
2-in. screenings	J	10.39	4.30	2,404
Clean coal at 1.40 sp.gr. float	J	7.68	2.24	2,286
3-in. lump coal	K	6.49	0.90	2,769
Bone coal (impurity)	K	45.99	0.35	2,958*
Face sample	L	2.40	0.62	2,470
Soft fireclay bottom	L	....	....	2,760
Face sample	M	6.76	0.82	2,650
½-in. soft fireclay parting	M	....	....	2,705
Face sample	N	6.04	0.80	2,740
Fireclay bottom	N	....	....	2,750
Face sample	O	6.85	0.74	2,550
3-in. draw slate	O	....	....	2,700
4-in. laminated coal	O	....	....	2,710
Face sample	P	10.35	0.68	2,273
Black "rash" or bone	P	49.57	2.23	2,606
Face sample	Q	11.33	0.65	2,650
Bone	Q	42.45	....	2,772

* Not fused.

In the accompanying table are shown figures that were obtained on the same coal either by sizing at the mine, taking face samples of the seam, or using solutions of varying specific gravity to cause the lighter and best coal to float and the heavier pieces of slate, sulphur, etc., to sink. Fusion temperatures were obtained for such impurities as slate, bone and fireclay, which are encountered in mines in the every-day production of coal and cannot be totally eliminated. Each group is of a different coal, but the results in each individual group are on coal coming from the same mine, although varying in size or degree of purity.

With few exceptions it will be seen that the fusion temperature increases as the ash increases. It must not be construed, however, that this will be the case with every coal. Too much importance has been placed upon sulphur content being directly responsible for bad clinker formation. It will be seen from the data in the table that frequently a high percentage of sulphur and a high fusion temperature go together. This may be seen in the samples from minus F, G, I, J and P.

Screenings usually carry a comparatively high ash content, and yet it is this size of coal that is put to the hardest test, as it is used on equipment where high furnace temperatures are maintained and a high fusion point is desirable. If mine run or lump of the same coal were crushed to the size of screenings and put to the same test, owing to a lower ash content and a lower fluxing temperature it might be expected that clinker would form sooner and be more troublesome than when burning screenings. Lump and egg size are almost invariably used for domestic heating, and with certain exceptions are burned in equipment where high temperatures are not so necessary.

The reason for the fusion temperature increasing with the percentage of ash is due to the fluxing taking place at a higher temperature, because some of the impurities themselves, such as slate, bone and fireclay, fuse at a much higher temperature than the ash in the coal. Some of these impurities are of such a texture that they break up easily into small pieces and thus are to be found in screenings.

Summing up the data in the table into one sentence, this might be said: Ash in coal as it is commonly known, plus an additional amount of slate, fireclay, bone, etc., may have a higher fusion temperature than the intrinsic ash in the coal itself.

Employer Must Supply Safe Working Place

By Leo T. Parker

AN EMPLOYER is bound to supply a reasonably safe place for his employees to work. He is not, of course, obligated to supply a perfectly safe place, but the law requires him to exercise ordinary care to know with reasonable certainty that his workmen are unlikely to sustain injuries while they are exercising diligence to safeguard themselves.

The same requirements apply to the kind of tools with which employees are expected to work. While an employer is not required to foresee unusual accidents, or to discover latent defects not discoverable by reasonably careful inspections, yet he will be liable if a workman is injured as a result of working with defective tools or appliances unsuited in safely performing his duties.

For these reasons employers may importantly reduce the chances of liabilities as a result of injuries to employees, by inspecting or having inspected equipment at regular intervals. The inspectors, however, must be reasonably competent to perform the work efficiently.

Moreover, it is an employer's duty to repair defective tools and other equipment immediately after receiving information of the necessity for repairs. If the employer or the workman's superior instructs the employee to proceed with his work under a promise that the repairs will be made soon, the employer lays himself liable if the workman is injured before the repairs are completed.

However, if the danger of continuing with the work is apparent to the workman, the court may hold the latter negligent in working in a place apparently dangerous under which circumstances the employee may not be entitled to compensation.

Combustion Control Formulas

VII—Fuel and Operating Efficiencies

By E. A. Uehling

M.E., Dr. of Engineering

In THE previous article the application of the heat-loss analysis to various types of fuel was illustrated by assuming that a given boiler was fired at successive intervals with five classes of fuel and that combustion was carried on with 25 per cent excess air, that $T = 500$ deg., CO averaged 0.30 per cent, and a steam pressure of 200 lb. The heat-loss components obtained from these data were given in Table VI. Because the heating values of the various classes of fuels are not the same, the heat losses must be reduced to a percentage basis in order to make them comparable. Arranging the heat-loss components into appropriate groups and reducing to per cent of heat in the respective fuels, the results given in Table I are obtained.

The table shows, first, that the per cent of total heat loss increases as the weight of hydrogen H_f in the fuel increases; second, that the loss of unavailable heat also increases with the weight of H_f; and third, the loss of available heat decreases as the weight of H_f increases.

Groups 4 and 5 show how the savable heat losses are apportioned between the men responsible. Group 7

TABLE I—HEAT LOSS COMPONENTS

	Carbon	Anthracite	Bituminous	Fuel Oil	Natural Gas
Group 1. Total heat loss. Components $A+G+H+M+N$					
B.t.u.	2,755	3,299	3,829	4,849	7,810
Per cent	18.87	20.24	21.38	20.55	23.00
Group 2. Loss of unavailable heat. Components $B+I+K+N$					
B.t.u.	1,464	1,939	2,390	3,598	6,092
Per cent	10.03	11.90	13.35	15.25	17.98
Group 3. Loss of available heat. Components $C+G+L+M$					
B.t.u.	1,291	1,351	1,438	1,251	1,728
Per cent	8.84	8.34	8.02	5.30	5.08
Group 4. Heat loss chargeable to Firemen. Components $D+F+G+M$					
B.t.u.	953	974	1,027	739	1,025
Per cent	6.53	6.03	5.74	3.13	3.02
Group 5. Heat loss chargeable to Boiler Cleaner. Components $E+L$					
B.t.u.	338	377	410	512	703
Per cent	2.31	2.31	2.29	2.17	2.08
Group 6. Heat loss. Component M					
B.t.u.	420	420	420	.....	.....
Per cent	2.88	2.51	2.35	.....	.....
Group 7. Heat loss due to water vapor. Component H					
B.t.u.	.....	380	753	1,663	3,634
Per cent	.....	2.33	4.21	7.05	10.68
Group 8. Available heat in water vapor. Component L					
B.t.u.	.....	16	32	67	147
Per cent	.....	0.10	0.18	0.28	0.43

shows how the heat loss due to moisture in the gas increases with the weight of H_f, and group 8 shows that the available heat in the water vapor is only a small fraction of one per cent of the heat in coal, a trifle over 0.25 per cent in oil and less than 0.5 per cent in natural gas.

The heat-loss analysis brings out the important fact that the fuels vary considerably in efficiency. The efficiency of a fuel depends on how much of the contained heat it is theoretically possible to utilize. Thus, in comparing the heating value of fuels, we must deduct the unavailable heat as given for each class of fuel in group 2, Table I. If the unavailable heat equals H_u, then $\frac{(H_s - H_u) \times 100}{H_s}$ = fuel efficiency. Inserting the value of H_u for carbon from Table I in this formula, we have $\frac{(14{,}600 - 1{,}464) \times 100}{14{,}600} = \frac{13{,}136}{146} =$ 90.0 *per cent fuel efficiency.*

Proceeding in the same way with all the fuels, the following fuel efficiencies are found: Carbon, 90.0; anthracite, 88.1; bituminous, 86.7; fuel oil, 84.75; natural gas, 82.0. These are the theoretical maximum conventional boiler efficiencies obtainable with the respective fuels, under the assumed operating conditions as to steam pressure and insulation against radiation. The former affects components B and K and the latter component N.

It is desirable to establish an index of operating efficiency that will be more simple, more easily determined and therefore more useful to the operating engineer in his endeavor to maintain maximum boiler efficiency. The conventional formula for determining boiler efficiency is based on the heat utilized, thus

$$\frac{\textit{Heat in steam generated} \times 100}{\textit{Heat in fuel fired}} = \textit{per cent boiler efficiency.}$$

Since the heat in the steam generated plus the total heat lost must balance the heat in the fuel fired, boiler efficiency can also be determined by the formula,

$$\frac{(\textit{Heat in fuel fired} - \textit{total heat wasted}) \times 100}{\textit{Heat in fuel fired}} = \textit{per cent boiler efficiency.}$$

Thus boiler efficiency can be based on the total heat wasted as well as on the heat utilized.

It is difficult to determine the heat in the steam generated and more difficult to determine the true average heating value of the coal fired by the conventional methods. It is just as difficult to determine the total heat wasted. The equicalorific fuel unit eliminates the difficulty of ascertaining the heat in the fuel, and since only the controllable heat losses need be considered, the task of determining the necessary losses is reduced to a minimum. The ratio of the standard heating value, H_s minus the controllable heat lost, H_c, per pound carbon unit of fuel fired to H_s is a true index of operating efficiency, thus $\frac{(H_s - H_c) \times 100}{H_s}$ = per cent operating efficiency.

Operating efficiency is based on the controllable heat lost and therefore is theoretically 100 per cent attainable,

whereas the maximum conventional boiler efficiency depends on the efficiency of the fuel. An operating efficiency of 100 per cent would result if all the fuel fired was completely burned with the theoretical minimum weight of air required, and the temperature of the gas, in passing through the boiler, was reduced to that of the water in the boiler.

In the preceding article a complete analysis of the heat losses resulting when burning the principal fuels under identical operating conditions was made and the results given in Table VI. The sum of the controllable heat losses, H_c, are given for each of the respective fuels in Table I. From this table it is seen that for carbon $H_c = 1,291$ and $H_s = 14,600$. Inserting these values of H_c and H_s in the formula for operating efficiency, we have

$$\frac{(14,600 - 1,291) \times 100}{14,600} = 91.16 \text{ } \textit{per cent operating efficiency.}$$

Making the same calculations by using the respective value of H_c and H_s as given for the other fuels, the operating efficiencies are found to be as given in Table II.

TABLE II—OPERATING EFFICIENCY

	Carbon	Anthracite	Bituminous	Fuel Oil	Natural Gas
Hc	1,291	1,351	1,438	1,251	1,728
Hs	14,600	16,300	17,900	23,600	34,000
Operating efficiency per cent	91.16	91.71	91.97	94.7	94.92
Conventional efficiency per cent	81.13	79.76	78.62	79.45	77.00
Difference	10.03	11.95	13.35	15.01	17.89

The conventional boiler efficiency is given by the formula $\frac{(H_s - H_w) \times 100}{H_s} = \textit{per cent boiler efficiency,}$ when H_w = B.t.u. of total heat wasted. Inserting the value of H_s and H_w of the respective fuels in this formula the conventional efficiencies are obtained and included in Table II.

The difference between the conventional and operating efficiency is the per cent unavailable heat loss represented by the components B, I, K and N as given by group 2, Table I.

TABLE III—HEAT LOSS CHARGEABLE TO GRATE, FURNACE AND BOILER

	Carbon	Anthracite	Bituminous	Fuel Oil	Natural Gas
Group 1. Components of unavailable heat					
B	1,172	1,249	1,311	1,540	1,924
I	..	340	671	1,490	3,226
K	..	24	50	106	232
N	292	326	358	462	680
G_1 or (Hu)	1,464	1,939	2,390	3,598	6,092
Group 2. Heat loss chargeable to grate					
M	420	420	420	....	....
Group 3. Heat loss components chargeable to furnace					
D	272	278	378	445	556
F	78	83	91	111	161
G	183	193	202	244	305
G_2	533	554	607	739	1,025
Group 4. Heat loss components chargeable to boiler					
E	338	361	378	445	556
F	78	83	91	111	161
L	..	16	32	67	147
G_4	416	469	501	623	864
Group 5. $G_2+G_3+G_4$ sum of available heat losses					
G_5 or Hc	1,291	1,351	1,437	1,251	1,728
Group 6. Sum of all heat losses					
Gd or Hw	2,755	3,290	3,827	4,849	7,810

It may become desirable or even necessary to know the individual efficiency of one or all the principal parts of the boiler setting, namely: the grate, the furnace or the boiler. The analytical method of controlling boiler operation furnishes a ready means for determining these efficiencies. In Table III the heat losses are arranged in groups, consisting of the heat-loss components chargeable to the respective parts of the boiler responsible for the losses.

True efficiency is the ratio of the available heat supplied minus the available heat wasted to the available heat supplied. Thus if H_u = B.t.u. of unavailable heat in the fuel, then

$$\frac{[(H_s - H_u) - H_c] \times 100}{H_s - H_u} = \frac{[H_s - (H_u + H_c)] \times 100}{H_s - H_u} = \textit{per cent true operating efficiency.}$$

The function of the grate is to support the fuel without loss of combustibles, until these are completely gasified and burned. True operating efficiency is the ratio of energy delivered to the available energy received. All the potential heat energy contained in the coal fired is received by the grate, and it delivers to the furnace the total heat in the fuel less the loss through the grate. If all the combustible in the fuel were completely gasified, 100 per cent grate efficiency would result; but since there is a loss of G_2 B.t.u., $\frac{(H_s - G_2) \times 100}{H_s} = \textit{per cent grate efficiency.}$

TABLE IV—EFFICIENCIES

Efficiencies	Carbon	Anthracite	Bituminous	Fuel Oil	Natural Gas
True grate	97.1	97.4	97.6	....	....
True furnace	96.2	96.5	96.5	96.9	97.0
True boiler	96.5	96.6	96.5	96.8	96.8
True operating	90.2	90.6	90.7	93.7	93.8
Operating	91.2	91.7	92.0	94.7	94.9
Difference	1.0	1.1	1.3	1.0	1.1
Conventional	81.1	79.8	78.6	79.5	77.0
Fuel	90.0	88.1	86.6	84.7	82.1
Difference	8.9	8.3	8.0	5.2	5.1
Theoretical maximum operating efficiency	100	100	100	100	100
Operating	91.2	91.7	92.0	94.7	94.9
Difference	8.8	8.3	8.0	5.3	5.1

The grate delivers to the furnace $H_s - G_2$ B.t.u. of heat, largely in the form of gaseous fuel. The function of the furnace is to complete the combustion and deliver to the boiler all the heat liberated. A furnace efficiency of 100 per cent would result if the combustibles received from the grate were completely burned with the theoretical minimum weight of air required. Since there is a loss of G_3, group 3, Table III, due to excess air and incomplete combustion, the per cent furnace efficiency is

$$\frac{[H_s - (G_2 + G_3)] \times 100}{H_s - G_2}$$

The function of the boiler is to absorb and transfer all the available heat delivered by the furnace to the water it contains. Since the boiler cannot reduce the gas passing through it to a temperature below that of the water, 100 per cent true boiler efficiency will result when $T = T_w$. Although actually $H_s - G_2$ B.t.u. per pound carbon unit of coal fired are delivered to the boiler only $H_s - (G_1 + G_2 + G_3)$ B.t.u. are available to it, and since G_4 = B.t.u. of absorption loss, we have

$$\frac{[H_s - (G_1 + G_2 + G_3 + G_4)] \times 100}{H_s - (G_1 + G_2 + G_3)} = \textit{per cent true boiler efficiency.}$$

Inserting the values of H_s, H_u, H_w, H_c and the respective values of G as given in Table III in the respective formulas, the efficiencies as given in Table IV are obtained.

The table shows: First, that true boiler efficiency is practically constant for all fuels, which it should be when the same per cent of excess air is supplied and the gas

leaves the boiler at the same temperature; second, that conventional efficiency varies with the efficiency of the fuel fired; third, that operating efficiency also varies with the fuel efficiency; fourth, that the difference between operating and true operating efficiencies is practically constant and averages less than 1.25 per cent; fifth, since operating efficiency is 100 per cent attainable, the difference between 100 per cent and the per cent of operating efficiency is the per cent of heat theoretically savable, and since the fuel efficiency is the maximum conventional boiler efficiency attainable, the difference between fuel efficiency and conventional boiler efficiency should also represent the per cent of heat theoretically savable. The table shows that this is practically true. Since the difference between operating and true operating efficiency is practically constant, the former is as reliable an index of economic operation as the latter.

The losses that have been discussed are the theoretically savable losses; but it is evident that neither the theoretical maximum per cent of CO_2, MCO_2, nor the theoretical minimum temperature of the gas, T_w, are attainable in practice. It is advisable therefore, even if not absolutely necessary, to establish by a series of tests conducted for the purpose, the most economical per cent of CO_2 and the lowest gas temperature that is practically possible to maintain.

The most economic per cent of CO_2, which we will call NCO_2 (normal CO_2), that can be maintained depends on, a, the ratio of the combustion space to the area of the grate, b, the heat endurance of the furnace, c, the method of firing and, d, the class of fuel fired. Normal CO_2 is practically constant for any given boiler. Normal gas temperature NT depends on the temperature T_w, the ratio of the volume of the gas path to the area of heating surface exposed in the path, and the volume of gas produced in a unit of time. Of the latter the $\sqrt{Bd}$ is the index. Both NCO_2 and NT must be determined for each size and type of boiler by careful tests.

The author has no knowledge of such test ever having been made,[1] but with the equipment advocated, an experienced operating engineer will have no difficulty in determining NCO_2 and NT. The procedure must be deliberate, passing in easy stages from the lower to the higher percentages of CO_2.

Normal CO_2 is practically independent of the rate of combustion and should therefore be determined at the normal rate of driving. On the other hand, NT depends on the CO_2 as well as the rate of combustion. The relation of NT to $\sqrt{Bd}$ must, therefore, be determined at varying rates of CO_2 as well as varying rates of combustion. In determining NCO_2 and NT, the following conditions must be observed: The setting must be practically tight; the heating surface must be clean inside and out; only one change must be made at a time.

Assuming NCO_2 and NT to have been determined, then X corresponding to NCO_2 will be NX, which represents the lowest value at which X can be maintained in practice, and NT the lowest maintainable temperature of the gas on leaving the boiler. The theoretical minimum value of X is X_m, and NX is the lowest value to which X can be reduced without excessive damage to the furnace by excessive temperature or undue loss from incomplete combustion. NT is the temperature at which the gas will leave the boiler when the heating surface is clean, the baffling intact and the setting tight. Therefore, if we substitute NX for X_m and NT for T_w, we have $(X - NX) \times T =$ B.t.u. loss of practically savable heat due to excess air, and $10{,}160 \times (Y - NY) =$ B.t.u. loss of practically savable heat due to incomplete combustion. The firemen are responsible for both of these losses. The B.t.u. loss of practically savable heat due to excess temperature is $NX \times (T - NT)$ and is chargeable to the boiler cleaners.

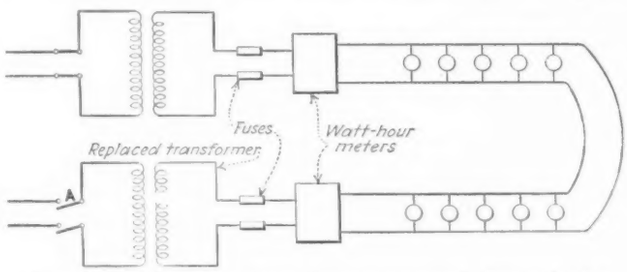
[In the next article of this series the author develops a *just* bonus system based on these three simple formulas.—Editor.]

[1] An account of tests of this nature made by A. K. Bak at the Connors Creek Plant of the Detroit Edison Company was published in the April 22, 1924, issue of *Power*.—Editor.

Theft of Electric Current Nearly Causes a Fatal Accident

By George N. Richter

ELECTRICAL accidents happen in all kinds of ways, but beating the watt-hour meter is about the prize cause. An electrician was sent to a large building to change a transformer on the second floor. Before the work was started, the switch in the feeder supplying the transformer was opened as shown at *A* in the figure.



Two transformers were interconnected through the low-voltage circuits

The transformer was replaced and the low-tension side connected without any mishap. When the high-tension side of the transformer was being connected to the switch, the electrician received a shock and was injured.

In looking for the cause of the accident, it was found that the new transformer was energized from the low-voltage side, which caused full voltage to exist on the high-voltage side. An investigation revealed that the circuit supplied from this transformer had been interconnected with the circuits that were supposed to be supplied by the transformer on the third floor.

It was found that the tenant on the third floor had made the connection so as to keep down the power recorded on his watt-hour meter. Part of the time he would remove the fuse on the low-tension side of his transformer and take power from the floor below him.

The foregoing was the condition that existed when the electrician went to replace the transformer on the second floor, which had been found to be operating at an excessive temperature. When the electrician disconnected the transformer, it left the third-floor circuits dead and the tenant on this floor replaced the fuses on his transformer, making not only the third-floor circuits alive, but also those on the second, where the transformer was being replaced. Unfortunately, the electrician did not discover that this condition existed while working on the low-voltage side.

INTERNAL COMBUSTION ENGINES

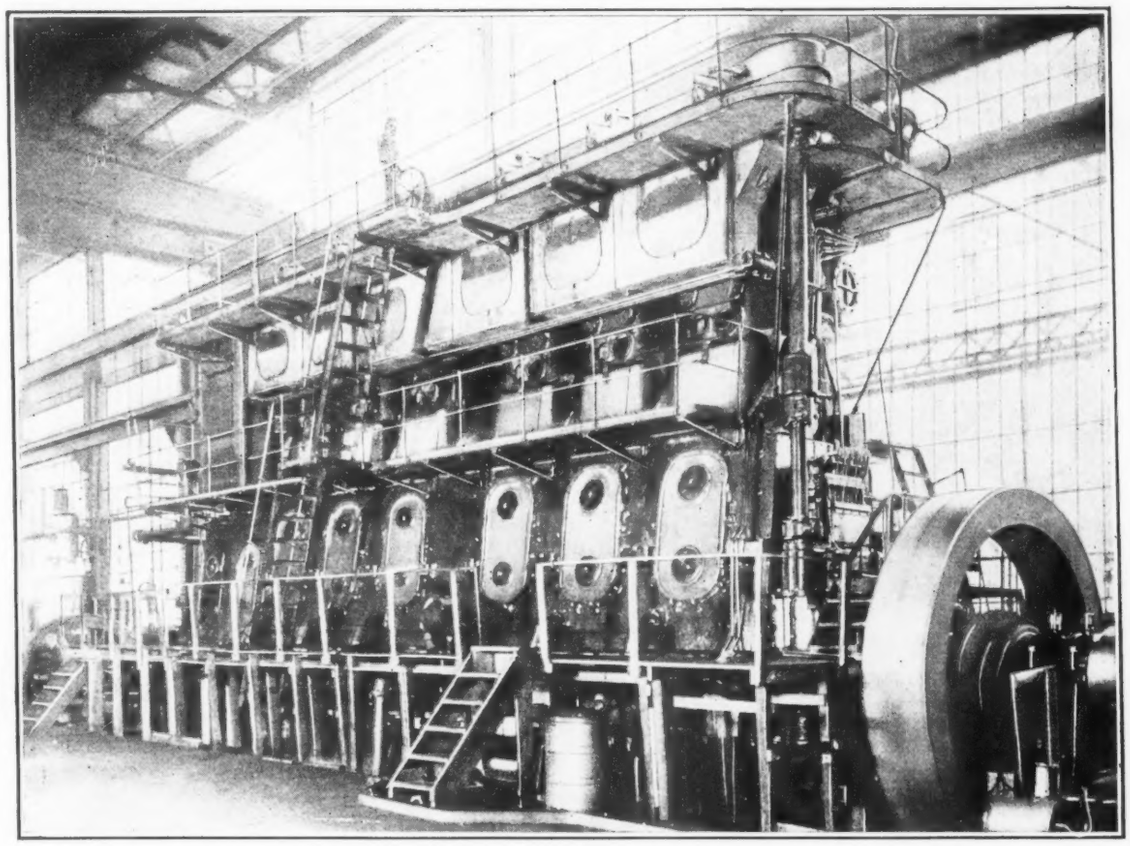


Fig. 1—The 3,750-hp. Busch-Sulzer Diesel on the test floor

A Four Thousand Horsepower Diesel In an Arizona Central Station

Tucson Gas & Electric Company installs largest stationary Diesel in America. Heavy oil will be burned. Lubricating oil will be treated chemically

THE largest Diesel so far built in this country has just been erected in the plant of the Tucson Gas & Electric Company, Tucson, Arizona. This engine is rated at 3,750 hp., but on the test floor developed over 4,000 hp. at 125 r.p.m., the six cylinders having a 30-in. bore and a 42-in. stroke.

It is planned to operate this engine on 16-deg. Baumé oil, and a centrifugal filter will be installed to clean this fuel before it reaches the engine's fuel pumps. Heating of the oil will be necessary even at the temperature prevailing in lower Arizona. Steam from a waste-heat boiler connected to the present exhaust lines of the engines now in the plant will be passed through coils to heat the oil in the storage tanks.

To purify the lubricating oil, a chemical oil-treatment plant will be used. This will consist of three tanks placed on a steel structure outside the building. The top tank will receive the dirty oil pumped from the engine's crankcase at stated intervals. After settling, this oil will flow into the tank below, where the liquid will be agitated by

INTERNAL COMBUSTION *Engines*

steam and soda ash will be added to coagulate the carbon particles. After cleaning, the oil will pass into the bottom tank, out of which it will be drawn for use.

Tucson is situated in the center of a sandy district, and even when no wind is blowing, the atmosphere is filled with minute particles of grit. To safeguard the engine against this gritty matter, all the air entering the scavenging pump will first pass through an air washer. This will consist of a tank where the air will be forced through a water-spray screen. Some engineers have expressed an apprehension that the moisture in the air trapped in the scavenging pump when the engine is shut down, might settle out upon the valves and cause corrosion. The plant engineers, however, believe that if this does occur, corrosion can be eliminated by arranging a bypass whereby the air can be drawn into the pump just before the engine is stopped without passing through the water spray.

The water is heavy with scale-forming material, and as is the case with the older engines, the new engine will use circulating water taken from a spray pond. The makeup will be treated, as now, by a zeolite process. The present apparatus has a capacity of 18,000 gal. before it needs to be treated with a salt solution; as 30,000 gal. makeup is needed each day, the softening apparatus is charged twice daily. This makeup comes from the city water mains.

With some of the present engines it has been found that oil enters the piston-cooling water, and for this reason the piston cooling water system is separated from the jacket cooling system. A surface skimmer is used, but the water and the oil form an emulsion that does not break up; the mixture is used in the system until it comes fairly thick, whereupon it is discarded. The same plan will be followed with the new unit.

At present the plant contains two 500-, two 520- and two 1,000-hp. Diesels, all of the four-stroke-cycle type; each of these is direct-connected to a 2,300-volt alternator. Two of the engines were installed in 1915 and represent early models. Owing to the load requirements it has been impossible to give the engines the needed attention and maintenance charges have been somewhat high. Cylinder liner wear has never been serious, and at present liners are being put into one of the engines that has been in operation for seven years without a liner renewal. The measured wear on the old liners was 0.12 in., or 0.017 in. per year.

Bearing wear has been unusually small. On one of the 1,000-hp. engines the main bearings show a wear of less than 0.002 in. in five years. There have been some cylinder-head fractures on the small units, but they have been due to the water. Such fractures have been "sewed" with threaded brass plugs with entire success.

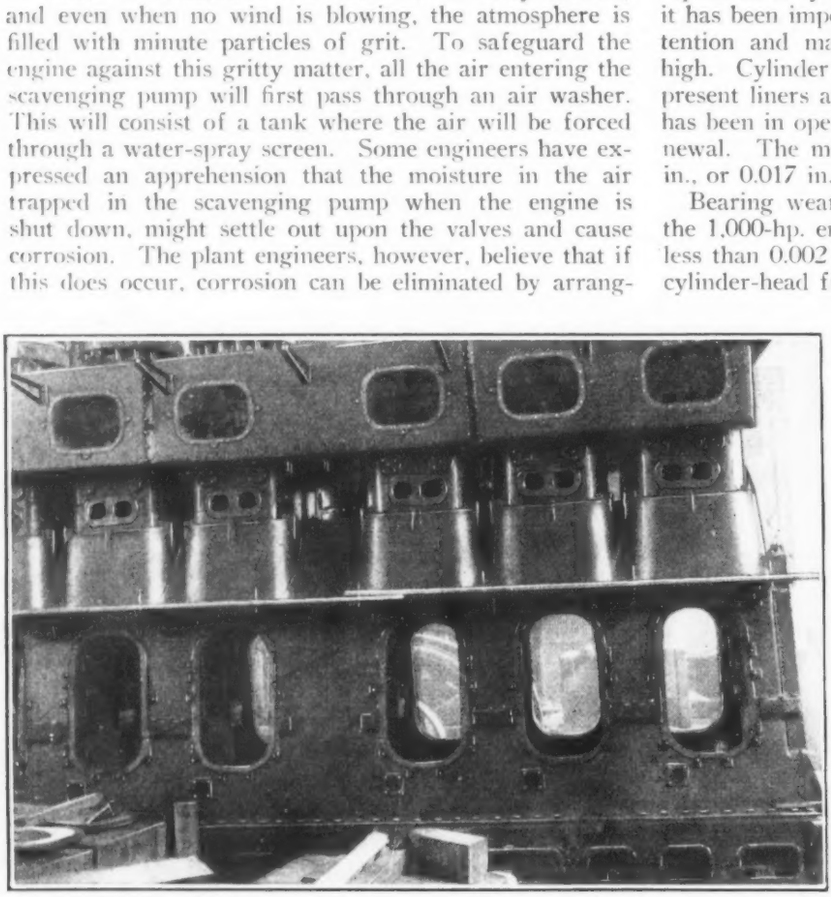


Fig. 2—The cylinders and base ready for the lighter parts

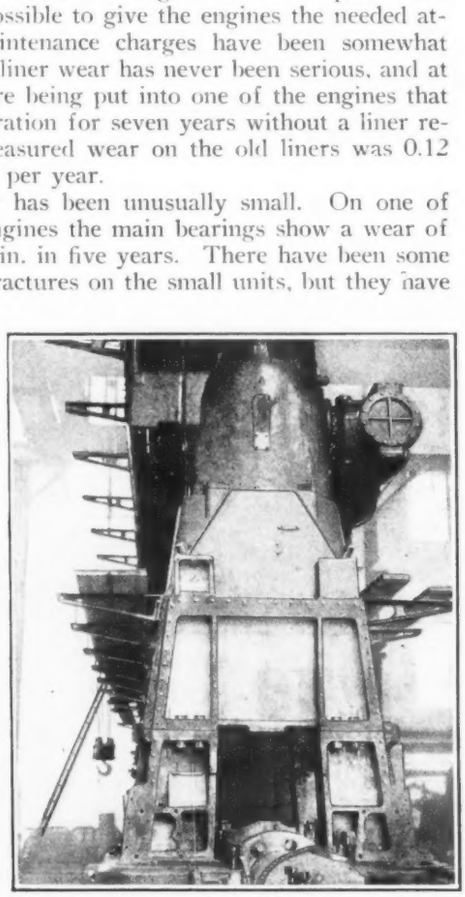


Fig. 3—End view of the engine

On one engine where the exhaust-valve cages were provided with thin copper sealing gaskets at the lower ends, at times the gaskets crimped, permitting gas to blow out along the joint. This rapidly cut away the metal, and it was necessary to build up the seats by welding. Gaskets have been eliminated, and the joints are ground in, with a metal-to-metal contact. The crankpin bearings on some of the smaller units require taking up every 30 days, but on the 1,000-hp. engines no perceptible wear of these bearings has occurred even after from three to five years' operation. This difference in wear is due to the use of gravity lubrication on the engines subject to the high wear and pressure feed on those showing little or no bearing wear.

All the present engines exhaust into separate lines which connect to a common corrugated-iron header buried in the ground. This header is run to a waste-heat boiler which is, in fact, an ordinary fire-tube boiler with the exhaust gases passing through the tubes and

INTERNAL COMBUSTION *Engines*

out to a vertical stack. It is estimated that about 500 lb. of steam is generated by the exhaust gases hourly, and this steam is piped to the adjacent artificial-gas plant. The corrugated iron header is objectionable in that it leaks at the joints, and as soon as the new engine is installed, a concrete tunnel will be built to accommodate all the units.

A regular schedule of operation and inspection is followed. Engines are run for 24 hours and then shut down while the others are started. All exhaust and admission valves are inspected and, if necessary, ground every thirty days. The air-compressor valves and the spray valves are inspected at the same time. While the compressor valves formerly gave some trouble, new valve designs have eliminated the difficulty. It is seldom necessary to regrind the spray needle valve, and about all that is necessary is to clean the atomizer disks.

To handle the 4,040 horsepower of engines now in the plant, there is a chief engineer, and on each shift there is a watch engineer and an oiler, but a second oiler is used on the night shift when the load reaches its peak. It is expected that the new engine will not require any increase in the operating force.

The present engines use 24-deg. oil that is shipped from California, and the freight charges are considerably more than the cost of the fuel at the refinery. As low as 16-deg. oil will be burned in the new engine, as it is felt that its design will permit the heavy oil to be used. The difference in the cost of the two grades of oil will mean a yearly saving of about $4,000.

Where Is the Power in a Double-Acting Diesel?

I HAVE noted the article by Donald McFee in the Dec. 27, 1927, issue of *Power*, entitled "Where is the Power in a Double-Acting Diesel?"

However, the author actually is considering power and I believe to many his article is misleading concerning the relative merits of the single- and the double-acting Diesel.

While the author gives the correct comparison between the actual force in foot-pounds per minute delivered to the crank during the respective *portions* of its rotation —that is, when the piston is moving up or down—this is not a true comparison of the powers developed by the respective ends of the cylinder or what either would develop if working alone.

The actual horsepower of any engine may be ascertained by the well-known formula, $Hp. = PLAN \div 33{,}000$, the correct quantities being substituted, of course. As the author has made no consideration for friction, that will not be considered now. If we have the same rate of compression in each end and ignore the added heat-absorbing capacity of the lower end, due to the presence of the piston rod, which is negligible, the mean pressure P will be the same in both ends, and as L and N are the same, the difference in $Hp.$ between the two ends will be determined by the difference in area, A, only. The difference is, of course, the area of the piston rod. In other words, the total assumed 1,066 hp. is divided between the upper and lower ends of the cylinder, as was given in the article referred to, 557 hp. and 505 hp. respectively.

The author of the article referred to has compared the effective forces in the upper and lower ends of the cylinder during the respective power strokes and has not given a comparison of the actual horsepower developed by the respective ends. The actual horsepower development of either end is the total horsepower minus the horsepower required to effect compression and exhaust in its own cylinder end, not that of the other cylinder end, as either end would if working alone.

There are many advantages in the double-acting gas engine, especially if of the two-stroke-cycle type. A great advantage is that the inertia of the moving piston, piston rod, crosshead and the component part of connecting rod, is resisted by the compression in the non-acting cylinder end, which pressure will also accelerate these bodies in the opposite direction. If the mass of this assembly and its rate of motion—that is, its inertia—be equal to its frictional resistance and resistance due to compression, no reversing stress will be exerted in the crankshaft, and the crosshead will cling to one guide only, which means that a much lighter crank may be used and the crosshead will have no tendency to slap. This would not be obtained, of course, with the rates of compression used in the Diesel, but it indicates that an added reciprocating mass is not a detriment but actually an advantage, in the double-acting Diesel.

The inertia to be established and then overcome, will be as great in the two-cylinder single-acting engine as in the single-cylinder double-acting engine of equal power. This will be affected by the compression with both types of engines, in one directly and in the other partly through the medium of the crankshaft.

The double-acting two-stroke-cycle Diesel engine will undoubtedly be developed beyond all others in the future, with the increasing demand for high efficiency, high power units of light weight and smaller dimensions.

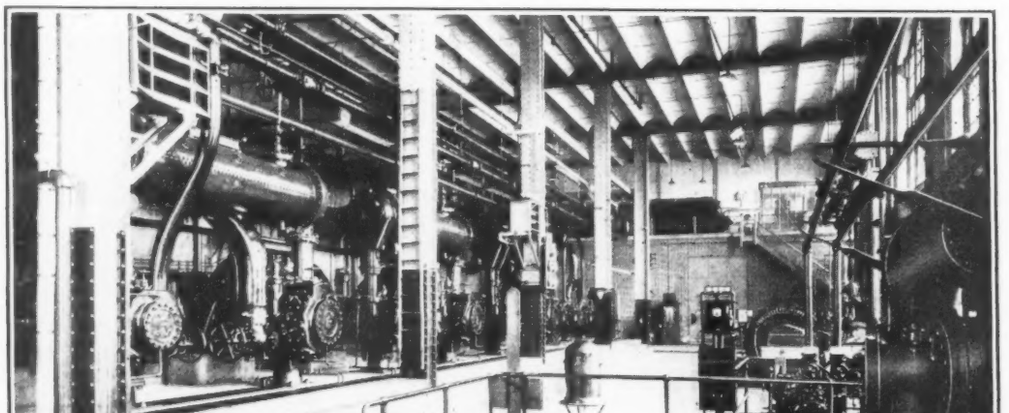
The effect of gravity is of no account, except that it causes a still greater amount of power to be transformed into flywheel energy, to be given up during the up stroke, in the single-acting, vertical engine. W. C. BAKER.

Cleveland, Ohio.

I HAVE read the comments by W. C. Baker with a lot of interest. He, however, has made the assumption that the horsepower developed in the cylinder was the subject of the article. A closer reading would have revealed that the power or, in other words, the net force exerted upon the piston was the matter under discussion. There is, of course, entire agreement with the advantages he has listed of the double-acting engine, but the fact remains that with the double-acting engine the variation in net force exerted on the piston must be found as I outlined and not by finding the difference between the expansion and compression curves on the indicator diagram obtained from one end of the cylinder.

Boston, Mass. DONALD MCFEE.

ELECTRICAL
Operation and Maintenance



Interior of compressor room has unusually pleasing appearance

Electrical Maintenance of a Large Refrigerating Plant*

Good design combined with careful operating and maintenance methods produces 100 per cent service.

PROPER design and maintenance are two of the most essential factors in obtaining continuity of service in plant operation. It is true that plants of poor design have made good records of continuous service, but this has been obtained at high maintenance costs. A well-worked-out design that combines high-grade equipment with a good operating arrangement results in reliable service with low maintenance costs.

Arrangement of equipment so that it will be easy to provide against emergency and will be easy to maintain cannot be overstressed. Main units that cannot be put into service because some auxiliary has failed, are operating under a hazard that may cripple the station at a most inopportune time. Furthermore, in fairness to those who must maintain the equipment, it should be arranged so that it is accessible without risk of injury to the operators. If the designers of the plant do not arrange the equipment so that it can be easily inspected and maintained, then if the operator does not develop 100 per cent enthusiasm for his work, he can scarcely be censored.

In the design of the plant of the Arctic Hygeia Ice Manufacturing Company, there is incorporated about every feature that provides easy operation and maintenance. Its record for continuous operation has justified the efforts put into the design. However, a plant cannot operate on design alone; it must be maintained, and it is with the maintenance of the electrical equipment in the plant that this article deals.

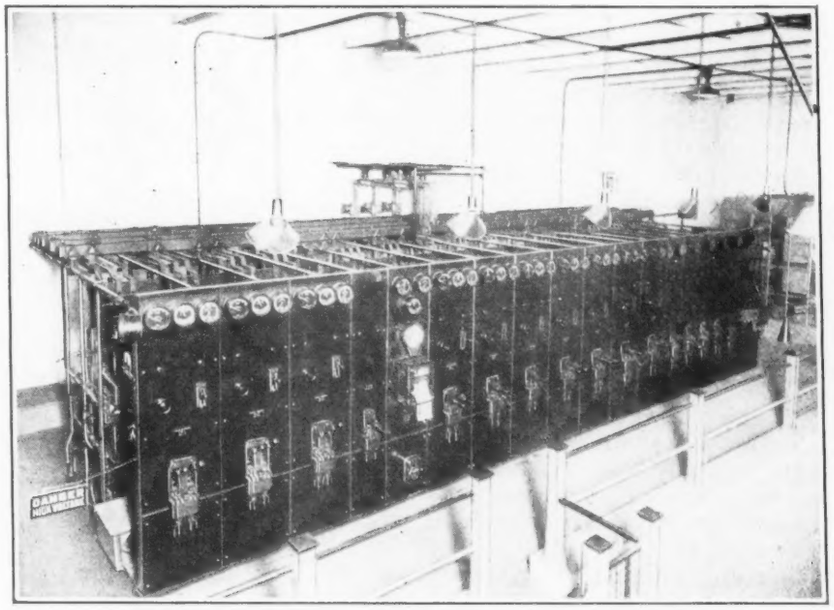
Among the chief items of electrical equipment in this plant are three 750-hp. and two 350-hp. engine-type

*The information in this article was supplied by B. Mohr, chief engineer, The Arctic Hygeia Ice Manufacturing Company, New York City. The photographs are by courtesy of Ophuls & Hill, Inc., consulting engineers, designers of this plant; and by Fischbach & Moore, Inc., the electrical contractors.

ELECTRICAL *Operation and Maintenance*

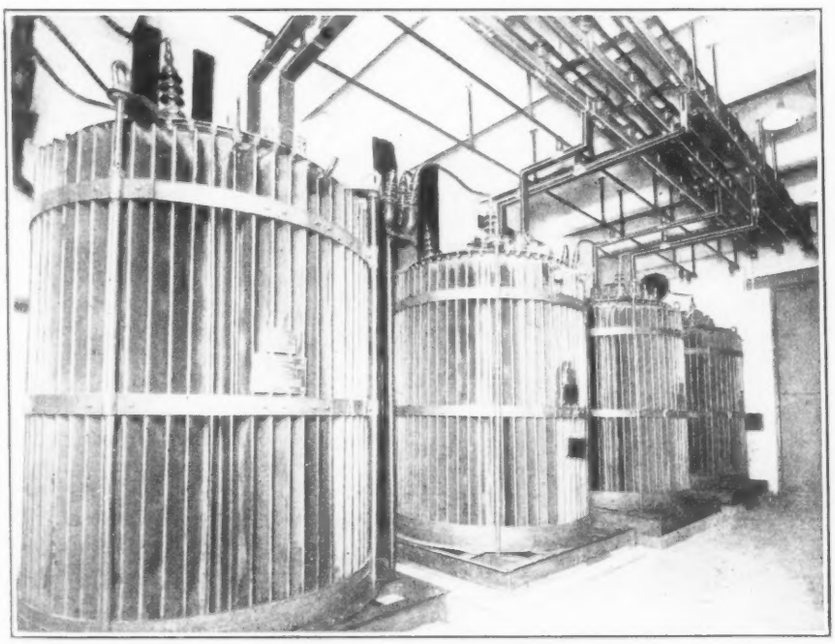
synchronous motors driving ammonia compressors; three 150-hp. synchronous motors directly connected to air compressors; two 100-hp. synchronous motors driving exciters; and about 80 auxiliary motors varying in size from ¼ to 100 hp. Most of these motors are of the squirrel-cage or slip-ring induction type. This plant, which has a daily capacity of 1,000 tons of ice, was originally steam driven and used distilled water for ice making, but was converted in 1922 and 1923 into a motor driven raw-water plant.

The electrical maintenance includes the power transformers. These are inspected daily, temperature readings taken, height of the oil checked and signs of unusual operation watched for. There are four transformers, three connected closed-delta, with a spare unit ready for immediate service. By the use of disconnecting potheads on the high-voltage side and special busbar connections on the low-voltage side, the emergency transformer can be quickly connected to take the place of any one of the three transformers used in the bank.



Oil switches are located away from the back of the switchboard for easy inspection

Yearly, each transformer is opened and an inspection made above the oil level. Samples of oil are taken from the top and bottom of the tank. Before taking the bottom sample, five to ten gallons are run off to make sure that the sample is representative of the oil. If the oil is below standard, it is treated in a centrifugal purifier to restore it to normal. When the transformers are being inspected, all potheads and their contacts are thoroughly cleaned. All connections on the low-voltage side are checked to see if they are tight and for any signs of oxidation. The insulators are cleaned and then given a 2,300-volt potential test to make sure that no defective parts are being overlooked.



A spare transformer has been provided for emergency

It is general practice to run a compressor for one week continuously, after it is put into operation. When the compressor is taken out of service after a week's run, the electrical maintenance men drop the tank on the motor's oil switch and inspect the condition of the oil and contacts, cleaning and adjusting the latter if this is necessary. In this plant this inspection can be easily made, as the oil switches are mounted away from the rear of the switchboard, so that they can be gotten at from all sides. The oil in the switches is changed when it begins to discolor, which is about once in three years. The discarded oil is not purified to be used again, but goes into the waste-oil supply and is used for rough lubrication purposes.

The compressor motors are started from a starting bus, which is supplied at a reduced voltage through duplicate reduced-voltage compensators. Only one of the compensators

ELECTRICAL *Operation and Maintenance*

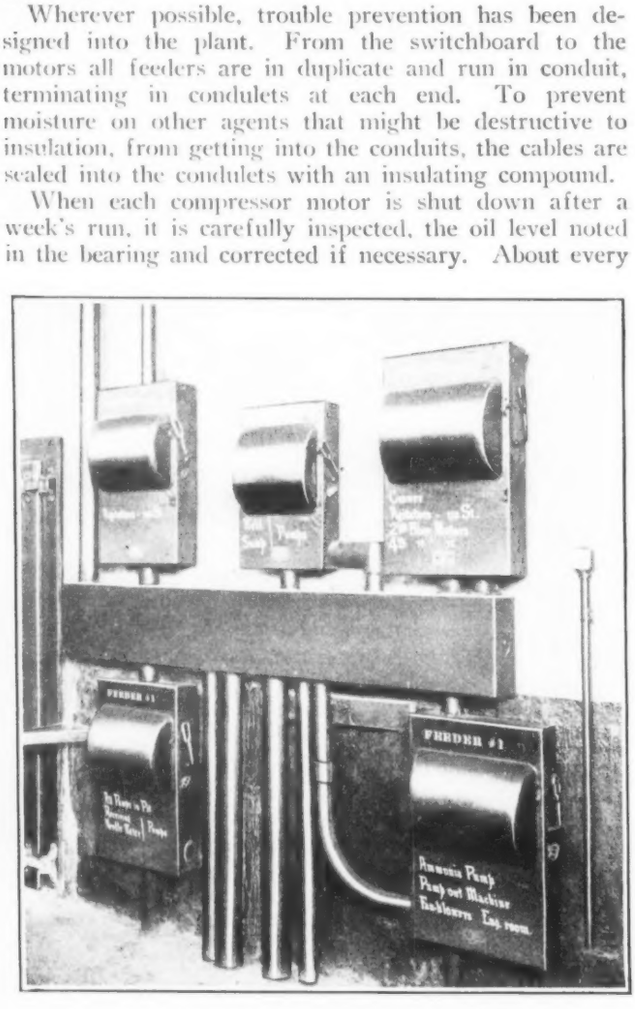
is used at a time, but each time one is operated its oil tank is dropped and the contacts inspected and any necessary adjustments made. To prevent the operator from leaving the main switch on the auto-transformers closed after a motor has been started, red and green lamps are used to show the position of the switch. A buzzer is also attached to this switch to sound as long as the switch is closed.

The busbars are located overhead between the oil switches and the rear wall. These busbars are regularly inspected for sign of connections that may develop heating or for other signs of impending trouble. Field rheostats for the synchronous motors are mounted on the wall away from the switchboard, so that they can be easily inspected and their contacts kept clean.

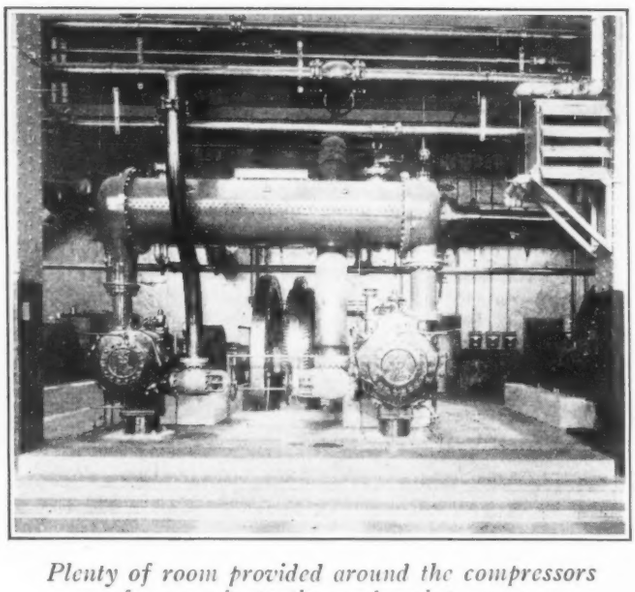
Around the switchboard, as in other parts of the plant, cleanliness is an important feature of the maintenance work. Not only is the board regularly inspected for loose or poor connections, but it is kept scrupulously clean, a portable vacuum cleaner being used extensively in the latter work.

Wherever possible, trouble prevention has been designed into the plant. From the switchboard to the motors all feeders are in duplicate and run in conduit, terminating in condulets at each end. To prevent moisture on other agents that might be destructive to insulation, from getting into the conduits, the cables are sealed into the condulets with an insulating compound.

When each compressor motor is shut down after a week's run, it is carefully inspected, the oil level noted in the bearing and corrected if necessary. About every



Inclosed-type safety switches have been used on all auxiliary power circuits



Plenty of room provided around the compressors for easy inspection and maintenance

two months the oil in the bearings is changed and the oil taken from the bearings is filtered. When the motors are in operation, the oil rings are checked by the watch engineer to see that they move freely.

After shutting down, the motor windings are cleaned with the vacuum cleaner and by wiping, and following an inspection the motor windings are meggered to check the insulation resistance. This is done every time a motor is taken out of service and a record kept of the insulation resistance. The insulation resistance of the motor windings includes the resistance of the cables running to the switchboard. This insures that any signs of insulation deterioration in any part of the electric circuit will be detected before a failure occurs.

Care of Auxiliary Motors

During the winter months only part of the plant's capacity is required to supply the refrigerating demands. It is at this time that each machine is given a complete overhauling. The motor winding and ventilating ducts are thoroughly cleaned by compressed air, by scraping and by washing with gasoline when the latter is necessary. After the windings are thoroughly cleaned, a good coat of insulating varnish is sprayed on them. When the mechanics have completed their work on the compressor, the electrical maintenance men check the position of the stator with relation to the rotor's poles. They make the necessary adjustment to give correct alignment and equal air gap between the rotor and stator.

The three air-compressor motors and the two exciter sets in the compressor room are given similar attention to that given the ammonia-compressor motors. The brushes on the commutator of each exciter are staggered to wear the commutator's surface as nearly equal as is possible. Any unevenness that does develop is taken care of by the application of a commutator stone when the machine is given its yearly overhauling. Each week

ELECTRICAL *Operation and Maintenance*

after the machine is shut down the slots between the bars are cleaned out. By this treatment commutator trouble is an unknown quantity and the wear on the commutators is practically negligible.

On the motors used for driving pumps and other auxiliary equipment, located in damp places, the oil is changed in the bearings every month. The oil taken from these bearings is not reclaimed, but goes into the waste-oil stock and is used for lubricating rough machinery around the plant.

While these motors are in operation, they are inspected daily for any indications of distress, and once a year each motor is taken into the shop and dismantled and thoroughly cleaned, after which it is put into an electric oven and thoroughly dried out, as indicated by a "Megger" reading. Then the windings are impregnated in insulating varnish and baked again. In all damp places, such as on the brine pumps in the tankroom, the windings are triple impregnated.

During the winter months, when part of the plant only is in service, the auxiliary motors are overhauled and those that are not required to go back into service to relieve other motors are retained in the repair shop until the full capacity of the plant is required in the spring. This prevents motors standing idle for long periods in damp places. Motor failures are rare, so much so that it has not been found advisable to maintain an armature winder. Any rewinding that has to be done is sent to an outside repair shop. In this way the work of the maintenance men is fairly constant in its character and inspections can be made at regular intervals.

Keeping Spare Equipment in Condition

On all the services a spare unit or a spare motor has been provided. Where a spare unit is available, it goes into regular service and is maintained in the regular routine. Where a spare motor is available, it is used to replace motors in service while they are brought into the shop for a cleaning, drying out and impregnating. It is the object to have every piece of equipment in the plant ready for instant service and to know it is, by putting it into regular operation. Spare equipment placed in the store room and not used until wanted is likely not to be in servicable shape when the emergency arises. During the first year that the plant was in operation, practically every possible emergency makeshift was tried so that in case such an emergency should arise it would be known what could be done and how to go about doing it. The combination of high-grade equipment, well engineered design of the plant, good workmanship in the installation and using foresight instead of hindsight in operation, has resulted in a record of 100 per cent service for five years. During this time it has never been necessary to take a unit out of service owing to trouble, and not a single part has been renewed on the main units.

In this plant the safety features have been given careful consideration. On all auxiliary motors, safety-type inclosed switches with fuses, or with inclosed circuit breakers, are used. The installations are made so that all wiring is thoroughly protected. All gears, chain drives and other moving parts that might endanger workmen are surrounded by adequate guards. The rooms that contain the high-tension incoming power equipment and the transformers are kept locked and only authorized persons have keys to enter these rooms. Access to the back of the switchboard is barred by chains having a high-voltage danger sign attached to them. Making the conditions safe for workmen to perform their duties is considered to be of equal importance with proper maintenance of the equipment in preventing plant failures.

Locating Trouble in Compressor Motor Controller

By I. S. Chamberlain

THE description of a low-pressure air alarm, by C. McEwan, in the Jan. 10 issue, recalls an experience which I had with a somewhat similar equipment, wherein it was found advisable to check up on some parts of automatic motor controls that are not usually suspected. A 500-volt direct-current motor was used to drive an air compressor, the motor being under automatic control, the starting and stopping times being determined by the position of two contact points on a pressure gage. The position of these contact points being adjustable, it was possible to vary the pressures at which the motor would start and stop, within reasonable limits.

About a year after the installation of this apparatus considerable annoyance was caused by the motor's failing to stop when the high-pressure point on the pressure gage had been reached. The motor would frequently continue to run until the safety valves on the air receiver operated, and could be stopped only by pulling out the main motor switch. When this manual operation was resorted to, the operators often forgot to close the switch after the air pressure had dropped a few pounds, which neglect resulted in a total loss of air pressure before the oversight was discovered, as the motor was thus left without current to start when the pressure-gage hand reached the low-pressure contact.

A thorough inspection was made of the contacts on the gage, as well as the various wiring on the motor control board, but no defects were revealed. After many unsuccessful attempts to detect the trouble, it was one day noted that the magnetic starting contactor on the control board failed to open when the gage hand contacted at the high-pressure point. This contactor remained closed even when the motor switch was pulled out, and it was found that the magnet core of the contactor retained sufficient residual magnetism to hold the contact closed after the magnet coil had been opened by the high-pressure limit on the gage dial. The ordinary jarring of the building was usually sufficient to cause the contactor to fall open some time after the motor had been stopped by the main switch, consequently the real cause of the trouble was not thought of at first. Proper adjustment of the contactor, to prevent actual touching of the magnet core by the armature of the contactor, remedied the trouble permanently.

Third Annual Mid-West Power Conference

Hotel Stevens
Conference Headquarters

OFFERING a program of unusual range and interest, the Third Annual Mid-West Power Conference, to be held in the new Stevens Hotel, Chicago, Feb. 14 to 17, inclusive, promises to surpass the preceding conferences in point of substance, appeal and attendance. Fundamentally, the program has been arranged to give a summary of the progressive activities and ideas of the leaders in the power field. The ultimate consumer of power in factory and home also has been remembered in that a special session devoted to the human interest aspects of power has been arranged for the opening day of the conference.

Specific topics of wide interest will be discussed at each session. General national interest centers on Wednesday's session, which will treat of power development in relation to flood and general river control. This is of particular interest to the Mississippi Valley where the Mississippi River floods recently wrought such havoc. The circle of interest is widened by the inclusion in the discussion of the problems of the Colorado, the Tennessee and the St. Lawrence Rivers. Such authorities as Gen. Edgar Jadwin, Prof. Daniel W. Mead, Col. William Kelly, Major G. E. Edgerton, Maj. L. H. Watkins, E. A. Forward of Montreal, F. A. Allner, and H. A. Hageman appear upon the program.

The sessions on Thursday and Friday will interest chiefly industrial and public utility representatives, as there will be papers dealing with the economics, operation and the trends in development of power plant equipment, with a luncheon symposium devoted to various phases of transmission. In these sessions speakers of national reputation will participate, including such authorities as Alex Dow, G. A. Orrok, Thomas E. Murray, Prof. S. W. Parr and others.

Registration of delegates will start promptly at 8:30 o'clock on the morning of Tuesday, Feb. 14. The initial session will open at 10:30 a.m. with addresses by Sewell Avery, president of the Commercial Club of Chicago; Major Rufus W. Putnam, president of the conference; and Glenn Frank, president of the University of Wisonsin. Mr. Frank is known as one of the most brilliant intellects in the college world, and his talk will be on "Power, the Background of Today's Civilization." Reference to the program will show what the afternoon's session has to offer in "Power Accomplishments in Factory and Home."

Owing to the brilliant success of a year ago, the annual banquet will again be made a feature of the conference. Rufus C. Dawes will address the audience, and the rest of the evening will be devoted to dancing in the grand ballroom of the Stevens Hotel.

On Thursday afternoon there will be an inspection trip to the great sewage disposal plant of the Sanitary District of Chicago. This plant, now

Grand Ballroom in which meetings and banquet will be held

Rufus W. Putnam
President

nearing completion, is the largest of its kind in the world.

For the convenience of those attending the Power Conference at the Hotel Stevens and wishing to visit the Power Show, which is to be held in the Coliseum, virtually continuous bus service between these two points will be established.

Members of the nine societies participating in the Mid-West Power Conference and their immediate families will be entitled to the usual half fare on the return trip provided a minimum of 250 certificates is secured.

The conference officers are Major Rufus W. Putnam, president; Alex D. Bailey, vice-president; George Pfisterer, secretary; and K. A. Auty, treasurer. On the conference committee, made up of two members from each of the nine societies sponsoring the conference, are: M. M. Fowler, B. E. Ward, American Institute of Electrical Engineers; W. Sykes, C. C. Whittier, American Institute of Mining Engineers; Thomas Wilson, James D. Cunningham, American Society of Mechanical Engineers; H. W. Fuller, R. F. Schuchardt, National Electric Light Association; W. D. Keefer, J. I. Banash, National Safety Council; A. L. Rice, J. L. Hecht, Western Society of Engineers; L. F. Harza, Murray Blanchard, American Society of Civil Engineers; A. J. Authenreith, B. E. Seamon, American Society of Refrigerating Engineers; A. B. Martin, N. G. Thomas, American Society of Heating and Ventilating Engineers.

George Pfisterer
Secretary

Program Mid-West Power Conference

Feb. 14-17, 1928, Chicago. Stevens Hotel, South Michigan Blvd., 7th St. to 8th St.

TUESDAY, FEBRUARY 14

8:30 a.m.—Registration.

10:30 a.m.—"Address of Welcome," by Sewell Avery, president of the Commercial Club of Chicago. Address by Major Rufus W. Putnam, chairman of Mid-West Power Conference. "Power, The Background of Today's Civilization," by Glen Frank, president of the University of Wisconsin.

2:00 p.m.—General subject, "Power Accomplishments in Factory and Home": "America's Part in the Romance of Power," by W. A. Durgin, Director of Public Relations, Commonwealth Edison Company, Chicago. "Drudgery Banished from the Home," by Mrs. J. D. Sherman, president, General Federation of Women's Clubs, Washington, D. C. "How to Make the Burden Bearer Bear the Burden," by Burke Corcoran, secretary of The Electric Association of Chicago.

WEDNESDAY, FEBRUARY 15

9:30 a.m.—General subject, "The Relation of Power Development to Flood Control and Other River Problems": "The General Flood Control Problems on the Mississippi System," by Gen. Edgar Jadwin, Washington, D. C. "Problems of Storage for Flood Control and for Power Development," by Prof. D. W. Mead, Madison, Wis. "Irrigation Flood Control and Power Development Problems on the Colorado River," by Col. William Kelly, Buffalo, N. Y. "The Status of Hydro-Electric Development from the Viewpoint of the Federal Power Commission," by Maj. G. E. Edgerton, chief engineer of the Federal Power Commission.

2:00 p.m.—"The Tennessee River Survey," by Maj. L. H. Watkins. "Navigation and Power Development on the St. Lawrence River," by E. A. Forward, consulting engineer, Montreal, Can. "The Combined Use of Water and Steam Power," by F. A. Allner, general superintendent, Penna Water & Power Co., Baltimore, Md. "Progress and Trend in Hydraulic Power Developments," by H. A. Hageman, chief hydraulic engineer, Stone & Webster.

7:00 p.m.—Annual banquet in the Grand Ball Room of the Hotel Stevens. Speaker of the evening, Rufus C. Dawes.

THURSDAY, FEBRUARY 16

9:45 a.m.—General subject, "Economics of Power Stations": "Capital Costs with Relation to Economy of Central Stations," by Alex. Dow, president of the Detroit Edison Company. "High-Pressure Operation," by G. A. Orrok, consulting engineer, New York City. "Trend and Development in Steam Generation," by Thomas E. Murray, New York City.

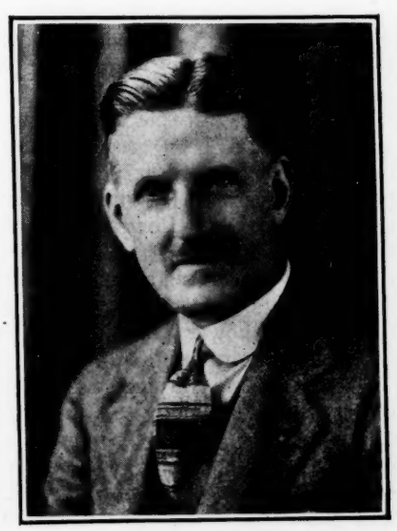
1:00 p.m.—Luncheon symposium on electric power transmission.

1:30 p.m.—Inspection trip for the afternoon to the sewage treatment plant of the Sanitary District of Chicago. This plant is the largest of its kind in the country and has many features of interest.

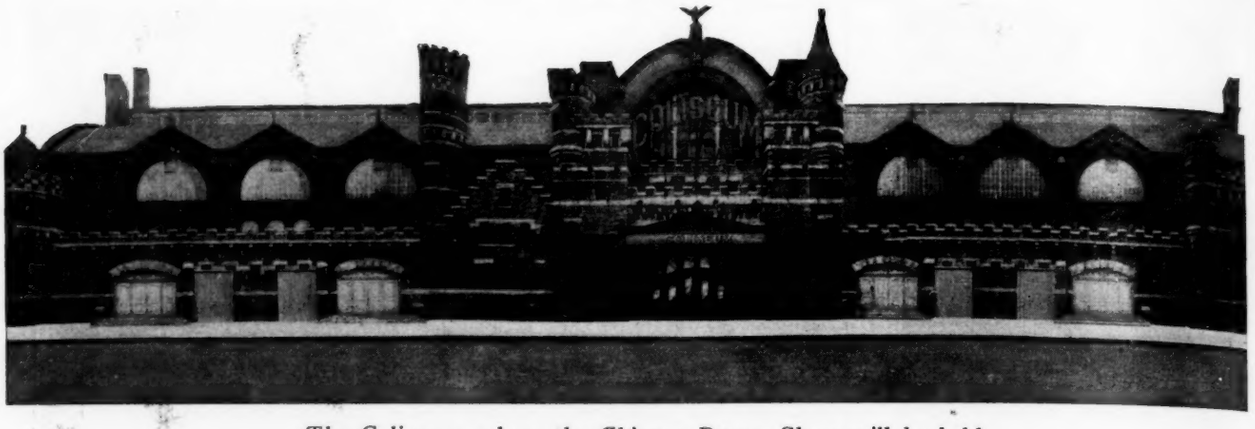
FRIDAY, FEBRUARY 17

9:45 a.m.—General subject, "Economics of Power Stations": "Combustion Control in Industrial Plants," by T. A. Peebles, Hagan Corporation, Pittsburgh. "Boiler Room Organization Combustion Control," by J. F. Shadgen, Smoot Engineering Corporation, New York City. "The Effect of Steam Reheating, Stage Feed-Water Heating and Boiler Reheating on Steam Turbine Practice and Development," by Edwin H. Brown, Allis-Chalmers Manufacturing Co., Milwaukee, Wis. "Embrittlement of Boiler Plate," by Prof. S. W. Parr and F. C. Straub, University of Illinois, Urbana, Ill.

Alex D. Bailey
Vice-President



K. A. Auty
Treasurer



The Coliseum, where the Chicago Power Show will be held

Third Annual Mid-Western Engineering and Power Exposition

PREPARATIONS have been practically completed for the opening of the third annual Chicago Power Show, which will be held at the Coliseum Feb. 14 to 18. Every available square foot of floor space has been contracted for, and the indications are that the coming show will outstrip the two previous ones. The show is being held simultaneously with the Mid-West Power Conference, a review of which also appears in this issue.

As might be expected, many of the exhibits will duplicate those shown at the New York Show early in December of last year. That, however, is of little significance, for the overlapping of attendance at the two shows is small—less than 5 per cent according to registration figures obtained at the previous shows held in each city.

The showing of pieces of equipment that have been recently developed or introduced into the power plant field, has now become an important feature of each Power Show, and the coming exposition at Chicago will contribute its full share. These new developments cover practically all branches of power plant as well as heating and ventilating equipment.

Examples of the latest developments in boiler design and construction will be shown by a number of manufacturers. These will include various drum sections, one of which will show the head shrunk on the outside of the ends of the drum, which is a departure from the long-standing practice of putting the shell over the head. Another manufacturer will show a section of a riveted joint in which each plate is 3 in. thick and the rivets 2½ in. in diameter and 11 in. long. The rivets are machined and the holes drilled to tolerance from solid plate, the rivets being driven by a 275-ton riveter. This is believed to be the heaviest work of this kind so far attempted.

Now that water-cooled furnace walls are in most cases connected directly into the boiler circulation the improvements made in these and the methods of connecting them to the boiler are of importance. Several improved walls will be shown and one manufacturer will demonstrate the adaptation of a completely water-cooled furnace to a boiler of the horizontal return-tubular type.

As an example of what is being done in superheater construction, one company will show a section of a header designed for 900 lb. working pressure. The header is forged from a solid billet and then bored eccentrically, the tubes being connected at the thick side of the header.

Several innovations in valve construction will be shown. Important among these is a new line of valves for high pressures and temperatures in which the valve seats are an integral part of a tapered removable valve cage. The cage is similar to a plug cock and may be utilized to shut off the flow through the valve while repairs or adjustments are being made. The feature of another exhibit will be one of the non-return valves being supplied for the Powerton Station of the Superpower Company of Illinois. These valves are designed for 900 lb. and are fitted with reduced ports and yoke construction of the double combination radial and end-thrust ball-bearing type.

New in the line of boiler accessories will be feed-water regulators which are controlled by a combination of steam flow and water-level movement. These regulators have been designed to meet the new demands imposed by the large modern boilers operating at high ratings.

In the field of pulverized-fuel equipment there will be improved unit pulverizers and short-flame burners of the turbulent type. To this might be added a number of devices for removing the fine ash particles from the gases of pulverized-fuel-fired furnaces. A number of these will be shown and the exhibits will include various types of separators and collectors and an induced-draft fan designed to serve as a cinder and dust eliminator.

The manufacturers of heating and ventilating equipment will be well represented and a number of new heaters and humidifiers will be shown.

The foregoing is a brief review of some of the new things to be seen at the show. More detailed information on the various exhibits will be found in the following list of exhibitors and their products.

Exhibitors at the Chicago Power Show and Their Products

A

AERO PULVERIZER CO., New York City. *Booth 180*—Improved Aero coal pulverizing unit and burning equipment.

AEROFIN CORP., Newark, N. J. *Booths 459-460*—Heating units with extended surfaces.

AIR PREHEATER CORP., New York. *Booth 74*—"Scene-in-action" photograph of Ljunstrom air preheater showing its operation, also models, and photographs.

ALBAUGH-DOVER MANUFACTURING CO., *Booth 333*—Line of speed reducers and gears, including vertical-type speed reducers, worm-gear speed reducers, both with the worm over and under the wormwheel and also spur-gear units. In addition a unit having a ratio of 800,000 to 1 will be shown.

ALEXANDER BROS., Philadelphia. *Booth 166*—A typical tentacular belt drive from a small to a large pulley.

ALLEN-SHERMAN-HOFF CO., Philadelphia. *Booth 104*—"Scene-in-action" pictures displaying the method of operation of the A-S-H hydro-jet ash removal system complete from furnace to ash loading hopper.

ALLIS-CHALMERS MFG. CO., Milwaukee. *Booths 91-92-93*—Texrope drive applications, roller-bearing motors, models of hydraulic turbine runners, and a large model of a 30,000-kw. steam turbine unit for Consumers Power Co.

AMERICAN ARCH CO., Inc., New York. *Booth 315*—Type A unit supported wall construction, suspended furnace arch and air-cooled bonded refractory wall.

AMERICAN BLOWER CO., Detroit. *Booths 8-9*—Sirocco flue-dust collector induced-draft fan, ventura disk ventilating fan and unit heaters.

AMERICAN PULVERIZER CO., St. Louis. *Booth 137*—An improved ring coal crusher of cast steel construction with manganese grinding parts and fitted with dustproof tapered roller bearings.

ANDREWS BRADSHAW CO., Pittsburgh. *Booth 139*—Tracyfier in operation under conditions that resemble those found in actual boiler operation as closely as possible.

ARMSTRONG MACHINE WORKS, Three Rivers, Mich. *Booths 403-404*—Complete line of Armstrong traps including steel trap for high pressures and a compound trap for handling large quantities of water at high and low pressures.

ATWOOD & MORRILL CO., Salem, Mass. *Booth 137*—Atmospheric relief valves, new type single-seated relief valve for steam extraction from turbines, adjustable combustion regulator and damper controls.

AUBURN STOKER CORP., Chicago. *Booth 447*—Semi-automatic and full automatic mechanical stokers.

AUTOMATIC PRIMER CO., Chicago. *Booth 466*—Automatic primer in combination with horizontal centrifugal motor-driven pump in operation under automatic control.

B

BABCOCK & WILCOX CO., New York. *Booths 171-172-211-212*—The exhibit of this company, which will be in conjunction with that of the Fuller Lehigh Co., will include a section of a 48-inch diameter Stirling drum; a section of a return-bend wrought steel economizer; a section of forged-steel superheater box; a vertical forged steel header built for 1,400 lb. pressure; a high-pressure water-gage glass and other fittings. There will be, in addition, a display of B. & W. high-grade No. 80 firebrick, in standard and special shapes. Also display of Enduro and Toncan iron tubes.

BAILEY METER CO., Cleveland. *Booths 213-214-215*—Meter panel boards, with a complete line of boiler meters. Electrically and mechanically operated fluid meters, pressure and temperature recorders and multi-point gages. Also boiler meter control drive for operating fuel valves, rheostats and controllers.

BARBER-GREENE CO., Aurora, Ill. *Booth 325*—Portable coal handling and conveying equipment.

BARCO MFG. CO., Chicago. *Booths 116-117*—Lubricated and balanced plug valves and flexible joints, also steam-jacketed valve for hot asphalt, tar, etc.

BARRETT-CHRISTIE CO., Chicago. *Booths 401-402.*

BARTLETT HAYWARD CO., Baltimore. *Booth 452*—Sectionalized models of Fast's flexible couplings with photographs and drawings of special applications.

BENTZ ENGINEERING CORP., Chicago. *Booth 469.*

BEARIUM BEARINGS, INC., Boston, Mass. *Booth 319*—New Bearium processed rod from ¼ to 1 in. in diameter, a representative line of cored and solid bars and special castings.

BERNITZ FURNACE APPLIANCE CO., Boston. *Booth 145*—A complete section of a typical water wall (Thayer type) fitted with carborundum water-wall blocks. Also ventilated types and carborundum S-100 boiler furnace blocks.

BETHLEHEM STEEL CO., Bethlehem, Pa. *Booth 189*—Bethlehem coal pulverizer of the roll tire type with dust-proof bearings, also demonstration models of Bethlehem backlash eliminator and torque amplifier.

BIGELOW-LIPTAK CORP., Mexico, Mo. *Booth 174*—Type S furnace wall construction for pulverized coal furnaces, single and double suspension arches, special arch block of high alumina or diaspore material, also type X refractory furnace wall construction.

BLAW-KNOX CO., Pittsburgh. *Booth 409*—Steel grating, clamshell buckets and continuous regenerative air heaters.

BOTFIELD REFRACTORIES CO., Philadelphia. *Booth 436*—Adamant gun for applying furnace linings. Adamant firebrick cement and Adachrome refractory material.

BOWSER, S. F. & CO., Fort Wayne, Ind. *Booth 164*—A feature of this exhibit will be the new Xacto meter in actual operation under conditions similar to those found in industrial plants. This meter is specially adapted for measuring low or varied rates of flow as on oil burning furnaces.

BRISTOL CO., THE, Waterbury, Conn. *Booth 309*—Complete line of indicating and recording gages and thermometers, pyrometers and liquid level gages.

BROS, WM., BOILER & MFG. CO., Minneapolis. *Booth 421*—Water-tube boilers.

BROWN INSTRUMENT CO., Philadelphia. *Booths 16-17*—Large model of the Brown electric flow meter illustrating the application of the induction-bridge principle to the meter, also flow meter accessories such as manometers, orifice plates and condensers, as well as other power plant efficiency instruments including indicating and recording thermo-electric pyrometers, CO_2 meters, draft, pressure and vacuum gages, thermometer automatic control equipments.

BUFFALO FORGE CO., Buffalo. *Booths 123-124-125*—A new induced-draft fan for use with pulverized fuel which will serve as a cinder and dust eliminator, also propeller fans, blowers and exhauster. Universal iron worker, multi-stage boiler feed pump, single-stage, double-suction ball bearing pump and a non-clogging sewage pump.

BUILDERS IRON FOUNDRY CO., Providence, R. I. *Booth 198*—Venturi meter for steam and boiler feed, also new shunt meter, which is a small compact meter designed for use on 2-, 3- and 4-in. steam mains.

BUNDY STEAM TRAP CO., Nashua, N. H. *Booths 454-455*—Complete line of Bundy steam traps.

BURHAM & LINDSAY, Chicago. *Booths 195-196.*

BYLLESBY ENGINEERING & MANAGEMENT CORP., Chicago. *Booths 118-119.*

C

CARBORUNDUM CO., Perth Amboy, N. J. *Booths 321-322*—Sections of boiler settings showing the application of carborundum bricks and shapes to air-cooled walls and water-tube side walls. Also "Infrax" insulating brick.

CARRICK ENGINEERING CO., Chicago. *Booth 312*—Electrically and hydraulically operated control for automatic regulation of combustion in boiler furnaces.

CARRIER ENGINEERING CO., Newark, N. J. *Booths 460-461*—A complete new model of Carrier centrifugal refrigeration unit, unit air conditioner for industrial plants, a gas heating and air conditioning unit for the home and a Gordon drier.

CARTER BLOXONEND FLOOR CO., Kansas City, Mo. *Booth 199*—Section of Carter Bloxonend type of flooring.

CASEY-HEDGES CO., Chattanooga, Tenn. *Booth 4*—Model of multi-pass boiler, also parts of boilers to show method of construction.

CASH, A. W., CO., Decatur, Ill. *Booth 167*—Models of complete line of Cash standard pressure reducing and regulating valves, working exhibit of the Craig system of automatic combustion control. Also

damper regulator strainers and pump governors.

CELITE PRODUCTS CO., Los Angeles, Calif. *Booth 10*—Sil-O-Cel insulating material, Celcote, and Fraxite high-temperature cement. A section of a breeching that is insulated on the inside.

CENTRIFIX CORP., Cleveland. *Booths 232-233*—Line of purifiers for steam, air and gas.

CHAPMAN VALVE MFG. CO., Indian Orchard, Mass. *Booths 33-34*—Chrome nickel steel gate valves, motor units for operating large valves. Also line of standard bronze and iron gate valves.

CHICAGO BELTING CO., Chicago. *Booths 463-464*—Leather belting, leather packing, belt dressings and cements.

CHICAGO CHEMICAL CO., Chicago. *Booth 165*—Testing kits demonstrating the use of sodium aluminate in connection with the treatment of boiler water.

CHICAGO PUMP CO., Chicago. *Booths 1-2-3*—Centrifugal pumps, including bilge pumps, vacuum and condensation pumps and receivers.

CHICAGO RHOPAC PRODUCTS, Chicago. *Booth 200.*

CLARAGE FAN CO., Kalamazoo, Mich. *Booths 226-227*—New type unit humidifiers and unit heaters; also a new improved exhauster in which any standard type of exhaust wheel will operate in the one fan housing.

CLEVELAND WORM & GEAR CO., Cleveland. *Booths 430-431*—Standardized line of industrial worm-gear speed reduction units including types for direct-connected load and over-hung loads; also the double-reduction and vertical types.

CLIPPER BELT LACER CO., Grand Rapids, Mich. *Booth 437*—Complete line of Clipper belt laces, and belt cutters with safety features, also belt hooks in the various makes and connecting pins.

COKAL STOKER CORP., Chicago. *Booths 189-190-191* — Cokal pulverzone semi-mechanical and mechanical stokers.

COMBUSTION PUBLISHING CORP., New York City. *Booth 25.*

COMPRESSED SPRUCE PRODUCTS CO., West Orange, N. J. *Booths 448-449*—Various articles made from "Spruce olite" compressed spruce including pulleys, non-metallic gears and pinions rolls for various applications, wheels, sheet & blocks for absorption of noise and vibration.

CONNEY & CO., INC., Philadelphia. *Booths 156-157*—Sections of breeching showing improved expansion stiffener and welded construction, also improved air cooled damper. Also section of duct work being supplied for the new Powerton power station of the Super Power Company of Illinois.

CONSOLIDATED ASHCROFT HANCOCK CO., INC., New York. *Booths 67-68*—Hancock forged steel-valves with bonnets for working steam pressures up to 450 lb. Forged-steel valves with flanged bonnets for pressures up to 600 lb. Cast-steel valves for pressures up to 1,350 lb. Cast-steel blow-off valves. Cast-steel drumhead stop and check valves. "Consolidated" cast-steel pop-safety valves and economizer relief valves.

COOK ELECTRIC CO., Chicago. *Booth 473*—Metal bellows of monel, brass and bronze, fuel-oil pumps and regulating devices.

COOKE SEAL RING, Chicago. *Booth 220*—Various types of pumps and refrigerating machines fitted with Cooke seal rings.

COPPUS ENGINEERING CORP., Worcester, Mass. *Booth 63*—Coppus van and turbo undergrate blowers, centrifugal turbo boiler feed pumps and various types of motor-driven blowers.

CRANDALL PACKING CO., Palmyra, N. Y. *Booth 193*—Complete line of metal packings and exhibits of raw materials entering into the manufactured packings.

CRANE CO., Chicago. *Booths 121-122-162-163*—Line of cast-steel valves for pressures up to 900 lb., trimmed with stainless steel; also iron and brass body valves in standard types.

CRANE PACKING CO., Chicago. *Booth 51*—Metallic packing for condenser tubes and tools for packing and belling the tube ends.

CROSBY STEAM GAGE & VALVE CO., Boston. *Booth 225*—Nozzle-type safety valve for 1,500 lb. pressure, reseating tool which permits the reseating of safety valves in position on the boiler.

CUTLER-HAMMER MFG. CO., Milwaukee. *Booths 110-111-112*—Across-the-line automatic starters, tubular and space heater and Dean system of valve control.

CUTTER ELECTRICAL MFG. CO., Philadelphia. *Booths 310-311*—A 2,000-amp. circuit breaker with reverse time limit, for use on 440-volt 60-cycle 3-phase circuits, a 1,000-amp. 3-pole semi-automatic transfer circuit breakers and a 2,000-amp. two pole field circuit breaker with reverse field discharge clips.

D

DAMPNEY CO. OF AMERICA, Boston. *Booth 76*—Apexior protective coatings for metal surfaces and the equipment for applying the coating. Also samples of boiler tubes that have been pickeled to remove mill scale, then apexiorized showing the condition of the coating after various lengths of service under operating conditions.

DAVIS, G. M. REGULATOR CO., Chicago. *Booth 86*—Pressure regulators of the piston and diaphragm type, stop and check valves, back-pressure and relief valves.

DEARBORN CHEMICAL CO., Chicago. *Booth 420*—Samples of Dearborn treating preparations, cleaners, lubricating oils and "No-Ox-Id" rust preventive.

DETROIT BELT LACING CO., Chicago. *Booth 471.*

DE WALT PRODUCTS CO., Leola, Pa. *Booth 342*—Various types of wood-working machines.

DIAMOND POWER SPECIALTY CORP., Detroit, Mich. *Booths 178-179*—A portrayal of the complete story of soot and ash deposit, their cause, effect and methods of removal, samples of various sorts of deposits and their chemical analysis. Also a new type of electrically operated automatic valved soot blower and a hand operated unit.

DIRECT CONTROL VALVE CO., Chicago. *Booth 228.*

DODGE MFG. CO., Mishawaka, Ind. *Booths 418-419*—Power transmission equipment including shaft hangers, split pulleys and bearings.

DRAKE NON-CLINKERING FURNACE BLK. CO., New York. *Booth 148*—Improved SX air-cooled wall; Simplesse gas heat burner and standard furnace blocks.

DRI-STEAM VALVE SALES CORP., New York. *Booth 323*—Stop valves in the angle and globe types of cast-iron semi-steel, bronze and steel.

DUNHAM, A. C. CO., Chicago. *Booths 173-210*—A working unit of the Dunham differential vacuum pump, condensation pump and receiver, also thermostatic radiator traps and valves.

DURAMETALLIC CORP., Kalamazoo, Mich. *Booths 410-411*—Durametallic packings in spiral form, also wedge and tapered jume ring assemblies.

DUST RECOVERY, INC., New York. *Booth 75.*

E

ECONOMY PUMPING MACHINERY CO., Chicago. *Booth 11*—Centrifugal boiler feed and standard pumps, automatic pump and return line pumps, non-clogging sewage pump.

EDWARD VALVE & MFG. CO., East Chicago, Ind. *Booth 79*—This company will feature one of the non-return valves which they are furnishing for the new Powerton Station of the Super-Power Company of Illinois. These valves are built to the 12-in. 900-lb. W.S.P. specifications and are provided with reduced ports. The yoke construction is of the new double combination radial and end-thrust ball-bearing type.

EHRET MAGNESIA MANUFACTURING CO., Chicago. *Booth 88*—Complete line of insulating material, including special high-temperature steam-pipe insulation and molded shapes for temperature of 1,000 deg.

ELLISON, LEWIS M., Chicago. *Booths 5-6*—Single- and multi-tube inclined and vertical draft gages, the straight-line-movement draft gages, U-path steam calorimeter, also new line of dial draft gages.

EVERLASTING VALVE CO., Jersey City, N. J. *Booth 45*—Regular and improved line of Everlasting valves in the angle and tandem types for pressure up to 600 lb.

EX-CELL-O-TOOL & MFG. CO., Detroit. *Booth 316*—Precision parts for Diesel engines, such as fuel-injection pump and spray nozzle.

F

FACTORY & INDUSTRIAL MANAGEMENT, Chicago. *Booth 12.*

FAFNIR BEARING CO., New Britain, Conn. *Booths 334-335*—Complete line of standard ball bearings in single- and double-row types, and radial thrust bearings.

FAIRBANKS-MORSE & CO., Chicago. *Booths 129-130-154-155*—A Diesel generating set, a high-speed high-head ball-bearing centrifugal pump. A well turbine pump and head, self-ventilated motors, warehouse and portable dial scales.

FILTRATORS CO., New York. *Booth 303*—New type air-cooled Filtrators in three sizes, also water-cooled filtrators with a new regulating trap and sight glass.

FISHER GOVERNOR CO., Marshalltown, Iowa. *Booth 37*—Pump governors, reducing valves, steam traps, float valves, and liquid-level controllers both direct connected and remote controlled. Also the new Fisher continuous sample head and turbulent- and centrifugal-type fluid mixers.

FOSTER ENGINEERING CO., Newark, N. J. *Booth 160*—Several different types of pressure regulators and pump governors, back-pressure and relief valves, also drop-forged cast-steel chrome construction non-return stop valves, fan-engine regulators and flow box in practical demonstration.

FOSTER WHEELER CORP., New York. *Booths 180 to 183*—Improved Aero unit coal pulverizer with separately driven magnetic feed mechanism, section of a new form of water wall in which each tube has separate wing castings fastened to the back. Foster sectional air heater, also samples of various superheater and economizer sections.

FOXBORO CO., INC., Foxboro, Mass. *Booth 61*—Boiler water level recorder, indicating and recording thermometers and gages, flue-gas recorders and tachometers.

FRANK, O. E., HEATER & ENGR. Co., Buffalo. *Booth 66*—Heat exchangers with split shell and U-tube heaters.

FULLER-LEHIGH Co., Fullerton, Pa. *Booths 168-169-170*—Displayor featuring sectional drawings, photographs and operating data on typical Fuller Lehigh storage and direct-fired pulverized-coal installations and typical Bailey water-cooled furnace wall installations, also sectional drawings of Fuller Lehigh pulverized-coal equipment, consisting of mills, feeding equipment, burners, transport system, waste-heat driers, furnace walls, etc. Bailey water-cooled furnace wall, erected, showing various types of refractory faced blocks and water-tube construction. Samples of refractory-faced and bare-iron water-cooled furnace blocks, and model of Calumet burner.

FURNACE ECONOMY Co., Chicago. *Booth 462.*

FURNACE ENGINEERING Co., New York City. *Booths 96-97*—The Simplex unit system of pulverizing and burning fuel, including the Simplex unit pulverizer, and Drake armor-clad wall construction. Also an animated picture showing the workings of the Simplex unit system as well as photographs of installations.

G

GARLOCK PACKING Co., Palmyra, N. Y. *Booth 453*—This company will feature a mechanical working model of crosshead and piston rod equipped with a set of Garlock oil-return packing and Garlock-800 Varitemp ammonia packing. This model is so arranged that a stream of lubricating oil is constantly running on the rod and the oil-return packing is cut away to show the function in removing the oil from the rod.

GRAVER CORP., East Chicago, Ind. *Booths 150-151*—Water softeners in the hot, cold, intermittent and zeolite types, also filters of the pressure and gravity types.

A. P. GREEN FIREBRICK Co., Mexico, Mo. *Booth 175*—Special high alumina brick, high-temperature air setting cement, and special "quik pach" plastic firebrick. Also standard line of firebrick, special fireclay, firebrick mortars and high-temperature cements.

GRINDLE FUEL EQUIPMENT Co., Harvey, Ill. *Booths 438-439*—Coal pulverizing and burning equipment

GRINNELL Co., Providence, R. I. *Booths 441-442*—Types of pipe joints including reinforced laps with plain, tongue and groove and Sargol faces, also special exhibit of a triple XXX lap joint under a microscope to show structure of metal at the joint.

THE GRISCOM-RUSSELL Co., New York City. *Booths 426-427*—U-fin air coolers, bent-tube evaporators, multiwhirl cooler and Reilly water heater.

H

HAGAN CORP., Pittsburgh, Pa. *Booths 58-59*—Combustion-control apparatus, deconcentrators, steam purifiers, and an electrically operated control apparatus for industrial furnaces. A working exhibit of the Hagan centralized boiler control system will also be shown.

HARRINGTON Co., JOSEPH, Harvey, Ill. *Booth 438*—"King Coal" overfeed type mechanical stoker.

HARRIS & Co., ARTHUR, Chicago, Ill. *Booth 222.*

HAYS CORPORATION, Michigan City, Ind. *Booth 313*—Gas analysis instruments and draft gages.

HEATING & VENTILATING MAGAZINE, Chicago. *Booth 471.*

HENSZEY DE-CONCENTRATOR Co., Watertown, Wis. *Booth 105*—De-concentrator with continuous blowdown for boiler concentration control.

HILL, E. VERNON Co., Chicago. *Booth 338*—Air testing instruments, filter gages, pitot tubes, dust testing outfits, psychrometers and microscopes.

HIMEBLAU, AGAZIN & Co., Chicago. *Booth 65.*

HOLLOW CENTER PACKING Co., Cleveland. *Booth 471.*

I

ILLINOIS ENGINEERING Co., Chicago. *Booths 405-406*—Eclipse steam traps and other steam and vapor specialties.

ILLINOIS STOKER Co., Alton, Ill. *Booth 138*—Drawings, photographs and copies of test of the Illinois natural- and forced-draft chain-grate stokers, samples of various stoker links for different fuels.

INDUSTRIAL POWER, Chicago. *Booth 62.*

INGERSOLL-RAND Co., New York. *Booths 108-109*—Complete line of Cameron pumps including a class "HMT" high-pressure multi-stage centrifugal boiler feed pump equipped with a hydraulic balancing drum to neutralize end thrust.

INSTANT WATER HEATER SALES DIVISION, Chicago. *Booth 401*—Instant water heaters.

INSULATING PRODUCTS CORP., New York City. *Booth 472*—Heat insulating products for various services.

INTERNATIONAL COMBUSTION ENGINEERING CORP., New York City. *Booths 28-29-30 and 54-55-56*—Couch adjustable burner for the horizontal firing of pulverized fuel, Lopulco preheated air burner, model of the C-E fin wall and C-E preheater showing the "S" flow design and new type clean-out doors, also a newly developed C-E liquid-level indicator for projecting an image of a water column at the operating floor level. Elements of various stoker and pulverized fuel products, such as grate bars, mill hammers, etc., will be displayed.

INTERNATIONAL ENGINEER, Chicago. *Booth 217.*

THE INTERNATIONAL NICKEL Co., New York. *Booths 141-142*—Commercial forms of monel metal and nickel alloys.

IRVING IRON WORKS Co., Long Island City, N. Y. *Booths 432-433*—"Irvico" type steel ventilating flooring, streamline flooring and vizabled safsteps, also the new Irving unified system of reinforcements and surface armour for concrete bridge floors.

J

JENKINS BROS., New York City. *Booth 202*—Full line of bronze and iron valves in both globe and gate types, "selclo" and rapid action types, also rubber packing and Moncrieff gage glasses.

JOHNSON SERVICE Co., Milwaukee. *Booth 300*—Heat-regulating devices.

JONES, W. A. FOUNDRY & MACHINE Co., Chicago, Ill. *Booth 90*—Spur- and worm-gear speed reducers, miscellaneous power-transmission appliances.

K

KELLOGG, M. W. Co., Jersey City, N. J. *Booths 102-103*—Samples of forge welded tongue and groove flanged joints, Kellogg-Van Stone pipe joints, forge welded pipe nozzle. "Dean" swing gate and slide gate valves, power operated.

KELLY VALVE Co., Chicago, Ill. *Booth 64*—"Neway" gate valves for steam, water, gas and oil. Features of these valves are self-cleaning seats, protected disks when the valve is open, and use of detachable inserts and seats permitting ten different service combinations for one valve.

KENNEDY-VAN SAUN MFG. & ENG. Co., New York. *Booth 445*—Animated picture of "Kennedy" pulverized coal equipment operating a steam boiler.

KIELEY & MUELLER Co., New York City. *Booth 402*—Steam specialties including back-pressure, atmospheric-relief, reducing, stop and check valves.

KLEMP, WM. F., Co., Chicago. *Booth 470.*

KORFUND CORP., New York City. *Booth 66*—Korfund vibro-dampers for isolating machinery against transmission of vibration and noise.

L

LA BOUR Co., Chicago Heights, Ill. *Booth 440*—The La Bour line of self-priming centrifugal pumps including a unit equipped for portable service driven by a gasoline engine. This company will feature its new corrosion resisting alloy "Elcomet."

LEAVITT MACHINE Co., Orange, Mass. *Booth 147*—Dexter, globe, gate, and pump valve-reseating outfits.

LEE, EARNEST E. Co., Chicago, Ill. *Booths 135 to 138-146 to 149*—Products of the companies which they represent. These include the American Pulverizer Co., St. Louis, Atwood & Morrill Co., Salem, Mass., Leavitt Machine Co., Orange, Mass., Manistee Iron Works Co., Manistee, Mich., Northern Equipment Co., Erie, Pa., and the Uehling Instrument Co., Paterson, N. J.

LIBERTY ELECTRIC CORPORATION, Stamford, Conn. *Booth 306*—Liberty valve operators and control boards.

LIMBERT & Co., GEO. B., Chicago. *Booths 131-132.*

LINDE AIR PRODUCTS Co., New York City. *Booth 324*—A specially designed and constructed header to show the various phases of construction through the use of the oxyacetylene process. Also welding and cutting equipment.

LOCKE REGULATOR Co., Salem, Mass. *Booths 454-455*—Damper regulators, balanced valves, pump governors, reducing valves and engine stops.

LONERGAN Co., J. E., Philadelphia. *Booths 454-455*—Pop safety valves, pressure and vacuum gages.

LOVEJOY TOOL WORKS, Chicago. *Booth 332*—A new line of L-R flexible couplings types A and B, also ball-bearing jacks, tube expanders and other boiler tools.

LUNKENHEIMER Co., Cincinnati, Ohio. *Booths 184-185*—A complete line of bronze iron body, steel and monel-metal valves.

M

MABBS, JOHN W., Chicago. *Booth 229.*

MANISTEE IRON WORKS Co., Manistee, Mich. *Booth 136*—Rees roturbo centrifugal pumps including one of the multi-stage horizontally split type and a single-stage horizontal volute pump.

MAPLEWOOD MACHINERY Co., Chicago. *Booth 343.*

MARION MACHINE FOUNDRY & SUPPLY Co., Marion, Ind. *Booths 407-408*—Type "A.B." balanced valve-at-head soot blower, type K heavy-duty full mechanical stoker and Marion water heater.

MECHANICAL MANUFACTURING Co., Chicago. *Booths 465-467*—Thermal Units products including unit heater for space heating and air conditioning, units for concealed and cabinet heating also units for blast heating and cooling.

MERCON REGULATOR CO., THE, Chicago, Ill. *Booths 106-107*—Various types of Mercon pressure regulators, including a constant excess pressure regulator for boiler-water level controllers.

MERRICK SCALE MFG. CO., Passaic, N. J. *Booth 308*—Merrick mechanical weightometer in operation. A mechanical weighman in operation on weigh tanks, also the Merrick addoweight for weighing buckets on an overhead track system.

MIDWEST PIPING & SUPPLY CO., St. Louis, Mo. *Booth 204*—Midwest new "globack" joints for 600, 900, and 1,350 lb. working steam pressure. Also a modification of the joint for high-pressure drip and drain lines.

MODINE MANUFACTURING CO., Racine, Wis. *Booths 340-341*—The Thermodine standard, cabinet and concealed heating units.

MOORE STEAM TURBINE CORP., Wellsville, N. Y. *Booth 196*—A new combined turbine and reduction gear for driving power plant auxiliaries, a combined high-speed boiler feed unit consisting of a single-stage turbine driving a 4-in. two-stage pump, equipped with an excess-pressure governor which works on the main governor valve of the turbine, also a pinion of a 1,500-hp. reduction gear.

MOREHEAD MANUFACTURING CO., Detroit, Mich. *Booth 413*—Morehead Back-to-boiler system.

MURPHY CO., J. W., Chicago. *Booths 313-314.*

MULTICELL RADIATOR CORP., Buffalo. *Booth 434*—Multicell radiators for heating and cooling services.

MURRAY IRON WORKS, Burlington, Iowa. *Booth 330.*

N

NASH ENGINEERING CO., So. Norwalk, Conn. *Booths 80-81-82*—Jennings-Hytor vacuum and condensation pumps for heating systems, compressors, pumps and sewage ejectors.

NATIONAL AIR FILTER CO., Chicago, Ill. *Booth 443*—Six distinct types of air filtration equipment, including Phoenix automatic, rotary, simplex, dri-drum, air-mat sectional and dri-dust separator.

NATIONAL COMPANY, Boston. *Booth 76*—Water column illuminators.

NATIONAL ENGINEER, Chicago. *Booth 69.*

NATIONAL POWER CONSTRUCTION, Chicago. *Booth 444.*

NATIONAL TUBE CO., Pittsburgh, Pa. *Booths 301-302*—Seamless tubing, pipe bends and flanges.

NAYLOR-HICKEY CORP., Chicago, Ill. *Booths 454-455.*

NELSON CORP., HERMAN, Moline, Ill. *Booths 20-21*—Unit heaters and invisible type radiators with wedge coil sections.

NORMAN-HOFFMAN BEARING CORP., Stamford, Conn. *Booths 35-36*—Complete line of ball, roller and thrust bearings.

NORTHERN EQUIPMENT CO., *Booths 135-149*—"Copes" feed-water regulator and pump governors, drainage control valve for 1,500 lb. pressure and a new combined feed-water regulator and governor.

NUGENT, WM. W. & CO., Chicago. *Booth 192*—Complete line of lubricating oil filtering, pumping and feeding equipment, including sight-feed valves with removable sight glasses and strainers.

NUWAY BOILER & ENGINEERING CO., Chicago. *Booth 115*—Photographs and drawings of installations of the standard Nuway boiler and the Nuway super-circulation water-wall boiler.

O

OBERMAYER, S., CO., Chicago, Ill. *Booths 456-457-458*—High-temperature cements and monolithic firebrick material, refractory shapes for special service conditions.

P

PAIGE & JONES CHEMICAL CO., Hammond, Ind. *Booth 339*—Water softening and filtering equipment.

PEABODY COAL CO., Chicago. *Booths 152-153.*

PEABODY ENGINEERING CORP., New York. *Booth 423*—Pioneer burner for pulverized coal equipped with insulated front, also the Peabody high-capacity gas burner, in which gas, oil or pulverized coal can be burned independently or in combination.

PERMUTIT CO., THE, New York. *Booth 224*—Model of water softening and filtering equipment such as is used in industrial plants. Also "Ranarex" CO_2 recorder for gas density, ammonia gas, etc.

PIPE BENDING PROCESS CO., Chicago. *Booth 331.*

PITTSBURGH PIPING & EQUIPMENT CO., *Booths 126-158*—Valves and samples of piping for high pressures and temperatures. Samples of wrought-steel welded headers, with welded-in nozzles and Sargol weld joint.

PLIBRICO JOINTLESS FIREBRICK CO., Chicago, Ill. *Booths 133-134*—Plibrico furnace lining and monolithic furnace construction and the flexo-anchor for securing the Plibrico wall to the common brick. Also section of water-cooled furnace wall on which plastic refractory is used to form the wall at the back of the tubes.

POPE CO., WM. A., Chicago, Ill. *Booth 85.*

PORTER-CABLE MACHINE CO., Syracuse, N. Y. *Booth 234.*

POWELL CO., WM. THE, Cincinnati, Ohio. *Booths 230-231*—Complete line of bronze iron, steel, globe angle, check, gate and safety valves, also a line of steel valves (hand and electric operated) for pressures from 150 to 900 pounds.

POWER, New York City. *Booths 31-32.*

POWER PLANT ENGINEERING, Chicago. *Booth 57.*

POWER PLANT EQUIPMENT CO., Kansas City, Mo. *Booth 412*—Complete line of Marley spray cooling equipment, steam superheaters and steam purifiers.

POWER PLANT SPECIALTY CO., Chicago. *Booth 40*—Chemical feeders for water softening systems.

POWERS REGULATOR CO., Chicago. *Booth 451*—Temperature and humidity control apparatus, steam traps and reducing valves.

POWER SPECIALTY CO., New York City. *Booths 180-1-2-3*—Sections of Foster sectional air heater, sections of Foster water-cooled furnace surface, superheaters and economizer and Foster water-back.

PRATT CO., HENRY, Chicago. *Booths 46-47*—Expansion joints and Phillips coal spout swinger.

PUBLIC SERVICE CO. OF N. ILLINOIS, Chicago. *Booth 203.*

Q

QUIGLEY FURNACE SPECIALTY CO., New York City. *Booths 13-14*—"Hytempite" for bonding firebrick and patching furnace linings; acid-proof cement for bonding and surfacing masonry and the Quigley refractory gun for furnace repairing.

R

RAILWAY & INDUSTRIAL ENGINEERING, Chicago. *Booth 304.*

RAMSEY CHAIN CO., INC., Albany, N. Y. *Booth 24*—Ramsey silent chain drives.

RAWLPLUG CO., INC., THE, New York City. *Booth 221*—Rawlplugs and a demonstration of their use.

READING STEEL CASTING CO., Bridgeport, Conn. *Booths 187-188*—An 18-in. iron-body gate valve equipped with motor operator, a "Series 90" cast-steel gate valve trimmed with rustless steel, a 12-in. Series 40 cast-steel tee, and a 12-in. Series 40 cast-steel gate valve equipped with motor operator. The latter valve is designed so that a motor operator can be readily attached either in the factory or in the field by merely removing the yoke cap and substituting a cast-steel bracket upon which the motor operator is mounted.

REED AIR FILTER CO., INC., Louisville, Ky. *Booth 450*—Automatic air filter, compressor filter, radiator cabinets and copper heating unit.

REEVES PULLEY CO., Columbus, Ind. *Booth 140*—A new design Reeves variable-speed transmission with double block V-belt and speed indicator.

REFINITE CO., Omaha, Neb. *Booth 219*—Water softening and filtering equipment.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland. *Booths 326-327*—A water- and dust-tight direct-current motor for driving stokers and other equipment subject to coal dust and moisture conditions. Alternating-current fully inclosed and fan-cooled motors, also motor with stator insulated to give protection against acids, dirt, steam and water.

REPUBLIC FLOW METERS CO., Chicago. *Booths 70 to 73*—Complete line of Republic instruments including flow meters for steam, water, air and gases; boiler meters, pyrometers, indicating and recording CO_2 meters, draft instruments, liquid-level and pressure recorders and indicators; also a new-type boiler meter panel including a multiple recorder which will record six records simultaneously.

RICHARDSON SCALE CO., Clifton, N. J. *Booth 328*—Apron-feed coal scales and hand weighing lorry.

RISHER FIRE BRICK CO., Chicago. *Booth 89*—Rentjes arch tile for flat, stepped or cantilever arches, also flexible corner bonding tile.

ROLLAND-GARDNER & CO., Cleveland, Ohio. *Booth 78*—Non-segregating coal distributors.

ROME BRASS RADIATOR CORP., Chicago, Ill. *Booth 337*—An all brass radiator unit known as "Robras" said to be 20 per cent the weight and size of cast-iron radiators of same capacity. Each section consists of two brass stampings electrically welded together.

ROWAN CONTROLLER CO., Chicago. *Booth 314.*

ROXANA PETROLEUM CORP., St. Louis, Mo. *Booth 307.*

S

SARCO CO., INC., New York City. *Booths 26-27*—Various types of steam traps for the industrial field, standard and special temperature regulators for hot-water service tanks, industrial processing, dry kilns, etc. Also special line of regulators for refrigeration work, suitable for temperatures from zero up.

SAUERMAN BROS., INC., Chicago, Ill. *Booths 18-19*—Equipment for storing and reclaiming coal.

SCHUTTE & KOERTING CO., Philadelphia, Pa. *Booth 60*—Double-duty boiler feed injectors, reducing valves, multi-jet con-

densers, radi-fin tube generator air cooler. Spur and herringbone rotary gear pumps, "Klinger" piston valves, and the Helpbringer electric control for motor-operated reducing valves.

SHEPHERD ELECTRIC CRANE & HOIST Co., Montour Falls, N. Y. *Booth 329*—Shepherd line of hoisting equipment.

S.K.F. INDUSTRIES, INC., New York City. *Booths 38-39*—S.K.F. ball bearings, including radial and thrust, single- and double-row bearing, hangers and pillow blocks.

SKEEN, D. H. & Co., Chicago. *Booths 74 to 79 and 102 to 107*—Standard lines of pressure regulators including constant excess pressure regulator used in conjunction with any type of boiler water level controllers. Also the products of the companies which they represent, including the Air Preheater Corp., Allen Sherman-Hoff Co., Dampney Co. of America, Dust Recovery, Inc., Edward Valve & Mfg. Co., Rolland-Gardner Co., Henszey De-Concentrator Co., M. W. Kellogg Co., Mercon Regulator Co., National Co., and the Tri-Lok Co.

SKIDMORE CORP., Chicago, Ill. *Booth 120*—Vacuum pumps for condensing and heating system.

SKINNER Co., M. B., Chicago. *Booth 15*—Skinner pipe joint, emergency and service pipe clamps, also high-pressure saddle, hand clamp and valve reseating tools.

SNAP-ON WRENCH Co., Chicago, Ill. *Booth 87*—Wrenches and tools.

SOUTHERN POWER JOURNAL, Atlanta, Ga. *Booth 50.*

STANDARD OIL Co., Chicago, Ill. *Booth 159.*

STANNARD POWER EQUIPMENT Co., Chicago. *Booths 83-84*—Cooling towers.

STERLING ENGINEERING & MFG. Co., Boston, Mass. *Booth 218*—Boiler-return, lifting, separating and vacuum traps.

STEPHENS-ADAMSON MFG. Co., Aurora, Ill. *Booth 209*—Coal handling and conveying equipment.

STOCKHAM PIPE & FITTINGS Co., Birmingham, Ala. *Booth 201*—Cast-steel flanged fittings and flanges for 150, 300, 400, 600, 900 and 1,350 lb. pressure.

STROM BEARINGS Co., Chicago. *Booth 23*—Standard line of single- and double-row radial, single- and double-row angular contact, adapter- and thrust-type ball bearings.

STRONG-SCOTT MFG. Co., Minneapolis, Minn. *Booth 186*—A working model of the improved "Unipulvo" Unit coal pulverizer.

STURTEVANT Co., B. F., Boston. *Booths 205-206-207*—Tubular- and plate-type air heaters and the new turbovane 1D fan in which the draft is regulated by tilting vanes in the fan inlet. This fan is designed for direct connection to motors or turbines and has a self-limiting norsepower characteristic which permits the use of a small driving unit and prevents overload.

SUPERHEATER Co., New York City. *Booths 127-128*—Enlarged sectional elevations of boilers with Elesco superheaters designed for pressure up to 385 lb., 735 deg. temperature and capacities of 500,000 lb. of steam per hour from one unit. Also a section of the new eccentric superheater header for high pressures and forged return bends for cooling coils for 3,000 lb. operating pressure.

T

THE SWARTWOUT Co., Cleveland, Ohio. *Booths 52-53*—Centrifugal-type separator for steam, oil and air, ventilators, low-pressure float-type and high-pressure bucket-type traps, also S-C feed-water regulators and pump governors.

TALCOTT, INC., W. O. V. M. W., Providence, R. I. *Booth 336*—Line of safety belt fasteners, clinching belt fasteners and special conveyor belt fasteners for canvas, rubber and textile belts, also belt fasteners from spring steel which eliminates hinges and pins.

THE TERRY STEAM TURBINE Co., Hartford, Conn. *Booth 422*—A 150-hp. Terry turbine designed for 200 lb. steam pressure and 50 lb. back pressure, suitable for driving pump, generator, pulverizer, paper machines and similar services. A complete rotor of a 500-kw. turbine of multi-pressure type for operating against back pressure up to 125 lb. or for bleeder and mixed pressure operation. Flexible shaft couplings in various sizes.

TEXAS Co., New York City. *Booths 428-429.*

THOMAS PUMP Co., Chicago, Ill. *Booth 468*—"Quimby" screw pump "Westco." high-head centrifugal pumps, Pulsometer steam pump, "Aurora" cellar drainer and the Ulmer sectioned deep well turbine for operating in wells from 4-in. up.

TIMKEN ROLLER BEARING Co., Canton, Ohio. *Booths 414-415*—Full line of Timken bearings for all kinds of industrial machinery, including railway journal boxes and steel mill roll necks.

TRANE Co., La Crosse, Wis. *Booths 143-144*—Return line pumps, vacuum traps and other heating specialties.

TRI-LOK Co., Pittsburgh. *Booths 332-333*—"Tri-Lok" steel gratings and treads.

TROY ENGINE & MACHINE Co., Troy, Pa. *Booth 197*—Small vertical steam engine of the heavy-duty or S-type in operation, also various working parts will be displayed.

U

UEHLING INSTRUMENT Co., Paterson, N. J. *Booth 149*—Line of CO_2 recorders and waste meters, vacuum recorders, combined barometer and vacuum recorders. Also new type electrically operated "Apex" CO_2 recorder.

THE UNISHEAR Co., INC., New York City. *Booths 416-417*—Several models of unishears.

UNITED CONVEYOR CORP., Chicago. *Booth 194*—A working model of a new type pneumatic conveyor for coal, soot and other granular material, operated by means of a motor-driven positive blower or multi-jet steam jet exhauster. Also a working model of a steam-jet conveyor discharging into a sectional cast-iron tank provided with steam jacketed plates at the gates to prevent freezing.

V

VASTINE SALES CORP., Chicago. *Booth 208*—Furnace fire observer.

HENRY VOGT MACHINE Co., Louisville, Ky. *Booths 424-425*—Drop-forged steel valves and fittings for high pressures and temperatures. A feature of this exhibit will be a section of a riveted joint in which the plates are 3 in. thick and the rivets 2¼ in. in diameter and 11 in. long, the rivets being driven with what is claimed to be the world's largest riveter (275 ton capacity). The rivet holes are drilled to tolerance from solid plate. This joint construction is used for high pressures, oil refinery work and other processes where unusually heavy plate is required.

THE VULCAN SOOT CLEANER Co., Du Bois, Pa. *Booth 195*—Self-contained valve operating head, ratchet operating soot-cleaner head and high-temperature heat-resisting elements.

W

WALSH-WEIDNER BOILER Co., Chattanooga, Tenn. *Booths 176-177*—A longitudinal section of a 54-in. steam drum for 450 lb. with the heads shrunk on the outside of the ends of the shell, standard high-pressure forged-steel sectional headers for 500 and 1,500 lb., also a section of the water wall for boiler furnaces, and a special high-pressure water gage.

WALWORTH Co., Boston, Mass. *Booths 98-99-100-101*—Valves for steam service in pressure from 150 to 1,350 lb., gate valves of Sigma steel body and Sigmalloy trim.

WARREN WEBSTER & Co., Camden, N. J. *Booths 41-42*—Modulation system of steam heating, packless valves, boiler return and vent traps. Also Webster "series 78" traps for process steam pressures.

WEBER INSULATIONS, INC., Chicago. *Booth 235.*

WELLMAN-SEAVER-MORGAN Co., Cleveland. *Booths 113-114*—The new Wellman Supertest gate and globe valves for high pressure and temperatures, in which the valve seats are an integral part of a slightly tapered removable valve cage of the plug type.

WESTINGHOUSE UNION BATTERY Co., Pittsburgh. *Booth 223.*

WESTON ELECTRICAL INSTRUMENT CORP., Newark, N. J. *Booth 305*—Portable and switchboard electrical indicating instruments and an improved electric speed indicator.

C. H. WHEELER MFG. Co., Philadelphia, Pa. *Booths 94-95*—Sectional model of a two-stage radojet air pump, with inter- and after-condenser; a three-stage radojet with two inter-condensers for producing a high vacuum, also Leach Fracto control condenser.

THE WICKES BOILER Co., Saginaw, Mich. *Booth 446*—Views of boilers in process of construction and actual installations. A section of Wickes single joint header and a model of the new three-drum curved-tube boiler.

WILLIAMS TOOL CORP., Erie, Pa. *Booth 400*—Pipe threading and cutting machines.

L. J. WING MFG. Co., New York. *Booth 318*—Turbine blowers for stokers and hand-fired plants, motor-driven blower for low-pressure heating boilers, low-ceiling type, feather-weight unit heater and a scruplex exhauster.

WORTHINGTON PUMP & MACHINERY CORP., New York. *Booths 48-49*—Two-stage steam-air ejector with inter- and after-condensers. A three-stage 4-in. centrifugal pump for oil field service and small centrifugal pumps of recent design.

WRIGHT-AUSTIN Co., Detroit, Mich. *Booth 435*—Line of steam specialties including weighted trycocks, water gage with glass replacing union, "Kleervu" gage-glass protector and Airxpel bucket trap.

Y

YARNALL-WARING Co., Philadelphia, Pa. *Booths 43-44*—Complete line of Yarway blowoff valves for pressures up to 1,350 lb. Involute spray nozzles and fittings. High- and low-pressure water columns with Yarway "Sesure" inclined water gage; also Lea V-Notch meter and hydraulic valves.

EDITORIALS

The Passing of a Great Engineer and Executive

IN THE death of General George W. Goethals, not only the United States, but the world at large, lost one of its foremost engineers. Like others of his capabilities, his achievements are many, but the one great work that overshadows them all was the building of the Panama Canal. This project had been the graveyard of blasted hopes for many years. Even so outstanding an engineer as Ferdinand de Lesseps, builder of the Suez Canal, saw his genius defeated by the difficulties lurking in the Panama jungles between the Atlantic and the Pacific.

This undertaking was in a bad way when, in 1907, President Roosevelt decided that a change in the policy of handling the work was necessary if it was to be carried to completion, and he placed the burden of the construction work on the Army engineers and made General Goethals, then a colonel, solely responsible.

One of the first problems to be solved was that of making the Canal Zone a safe place in which to live. To accomplish this task, the General took with him Colonel Gorgas, whose talent as a sanitary engineer has enrolled his name among those of the immortals. It is to the credit of this triumvirate, Roosevelt, Goethals and Gorgas, that the Panama Canal was completed in the face of almost insurmountable obstacles.

It was General Goethals' engineering skill, executive ability and administrative power, as director of the construction work and as the first Civil Governor of the Canal Zone, that made this waterway exceed the most brilliant expectations. For his untiring efforts and skill he will be long remembered as one who did much to make this world a better place in which to live.

The Plant Engineers Code

ONE of the smallest, yet most mutually helpful engineering organizations in New England, is the Plant Engineers Association. This group, limited to a membership of twenty-five engineers from twenty-five different industries in and about Boston, has found it profitable for several years past to meet once a month for the exchange of ideas and the discussion of problems common to their diversified duties. This Association has now brought out a Plant Engineers Code which represents a creditable and constructive attempt to define the plant engineer's status, his responsibilities and duties, especially as related to inter-departmental functions. An abstract of the Code appears in this issue.

The plant engineer is a product of modern industrial organization. The production man has become a specialist whose job is to secure production in required volume in the shortest time consistent with specified or improved quality and at minimum cost. His department must be supplied with the necessary power, steam for process, compressed air, hydraulic service, etc. Also, the plant must be heated and lighted, fire protection maintained, belts and motors serviced, repairs made to equipment and building, and extensions made as occasion demands. Responsibility for such engineering services, so vital to production, and the proper allocation of their costs cannot be split up among a number of individuals, but must head up in one executive engineer who is directly responsible to the management. This individual is usually the plant engineer, functionally speaking, although he may actually be designated by one of several titles. The multiplicity of responsibilities sometimes leads to confusion of authority in inter-departmental duties. In this respect the Code will serve to chart the way.

Organization details of the plant engineer's department differ with various industries and as between plants of the same industry. However, the Code, which represents the best thought of twenty-five New England plant managements, has been made comprehensive yet flexible enough to suit most cases. It can well serve as a yardstick for industrial establishments in other sections of the country, and assist in according the plant engineer his proper niche in industry.

Industrial Wastes and Power Plants

ATTENTION was called in one of the discussions at the meeting of A.S.M.E. last December to the effect of industrial wastes on boiler feed water problems and condenser operation. The report indicated that these wastes may be the cause of considerable expense and trouble to the power plant operator and that sufficient attention had not been given heretofore to the proper disposal of such wastes.

Instances of troubles in power plants from trade wastes are not rare by any means. One large central station has experienced much trouble in the fouling of its large condensers due to wastes dumped into the river from a glue factory farther upstream. Another large

station has had much corrosion trouble with condenser tubes due to acid refuse dumped into the cooling water by certain industrial works. Other similar instances of condenser trouble may be cited to show the serious effect of indiscriminate disposal of trade wastes.

When one attempts to use river or bay water, which is polluted by trade wastes, as boiler feed, a difficult problem is often presented. The plant operator has to go to considerable expense to install the proper treatment plant to neutralize any acids that may be present and to remove the scale-forming impurities. This treatment increases the amount of soluble non-scaling materials added in the feed water and makes additional blowing down necessary to keep the boiler concentration within reasonable limits. If evaporators are used, it is usually necessary to provide some treatment to the water before it enters the evaporator. In any case the presence of industrial wastes either in boiler feed water or in condensing water supplies generally leads to extra expense in the power plant and to considerable increases in the cost of power.

Have power plant engineers been negligent in protecting their interests by not taking means to stop this pollution of their water? Can such pollution be prevented and how? These are live questions that so far have not received much attention from engineers. There are cases on record where the government has stopped the dumping of certain liquors into streams. The industrial concerns which have had to revise their methods, have generally found that valuable byproducts can be obtained from these wastes and that it has proved profitable to save them when forced to stop dumping. If some action could be taken to prevent others from polluting streams with their wastes, money might be saved not only by the power plant operators but also by the industries themselves. Hence, stopping such industrial wastes may be a blessing in disguise.

What do engineers propose to do about this problem of growing seriousness?

Shall Process Steam Be Centrally Generated?

LONG-DISTANCE transmission of steam is familiar practice with central heating systems. But for other purposes, such as process work and power generation, it is uncommon; and, consequently, but little is known about it. A little thought on the matter, however, will indicate that the adoption of such a practice would cause far-reaching changes in present-day power generating methods. It is for this reason that particular interest attaches to an article on the "Long Distance Transmission of Steam," by C. W. Conrad, published on page 141 in last week's issue of *Power*. This article contains a discussion of central generation and long-distance transmission of steam for process work and predicts that these practices will soon be realities.

There is considerable doubt, however, as to whether this method can be as successful for process work as it is for building heating. Disregarding inertia on the part of both public utilities and manufacturing plants, which works against the adoption of revolutionary methods, the chief difficulty lies in the fact that in many cases the central station will not be able to compete with the isolated plant of modern design, even when it sells steam and thus improves its heat economy.

The reason for this is that in certain industries a balance between the heat and power requirements can be reached that results in approximately full utilization of all the heat in the steam generated, without incurring any of the heat losses that accompany central stations and long distribution systems. The final decision between an isolated plant or a central station, for the generation of both power and heating steam, can be made only on a dollars and cents basis. What that decision will be in any particular case, can be decided only as the result of a thorough engineering investigation. For many industries, however, central steam generation seems to promise a way out of present difficulties. For this reason the subject is one that deserves the serious study of engineers.

Imagine the Savings!

IMAGINE what a difference it would make in some plants if the industrial water service lines were as well designed and maintained as the power plant and fire service water lines. In certain paper mills, for instance, there are areas where it is almost impossible for a man to work, because of the water that leaks and drips over everything. And the need for wading boots and a slicker when making an inspection tour is by no means confined to the paper industry.

No such conditions exist in the well-managed power plant. And the power engineer, who knows how pipe lines should be installed and cared for, is the best available man to duplicate power plant conditions in the other departments. Of course, the power engineer cannot actually take this work away from someone else who is less experienced and skilled. But, if he could, it would be a good thing for some plants.

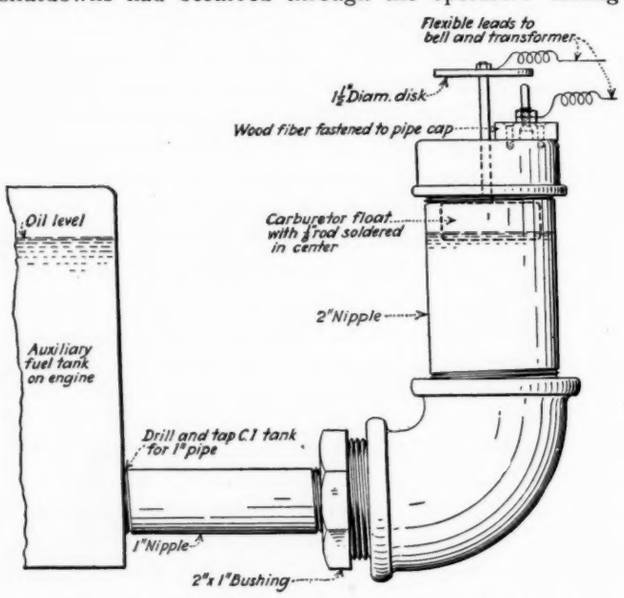
And the management sometimes does not seem to realize that leaking water pipes are the cause of much waste besides the water that is lost. Lower efficiency of workers and the corrosion of valuable equipment are two of the most important of such waste. If the management of a leak-afflicted plant became aware of the losses it suffered and then placed the responsibility for their avoidance, together with an adequate appropriation for pipeline maintenance, up to the power engineer, imagine the savings that could be made!

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Oil Level Alarm for Engine Fuel-Oil Tanks

IN THE plant where I am employed the generating units are driven by Diesel engines. After several shutdowns had occurred through the operators' letting


Flexible leads to bell and transformer
1½" Diam. disk
Wood fiber fastened to pipe cap
Oil level
Carburetor float with ¼ rod soldered in center
2" Nipple
Auxiliary fuel tank on engine
Drill and tap C.I tank for 1" pipe
1" Nipple
2" x 1" Bushing

Alarm warns of lowering oil level in fuel tank

the fuel tanks run dry, we equipped each of the engines with a simple alarm that has proved entirely satisfactory. The illustration is self-explanatory.

Pomfano, Fla. H. C. CUNNINGHAM.

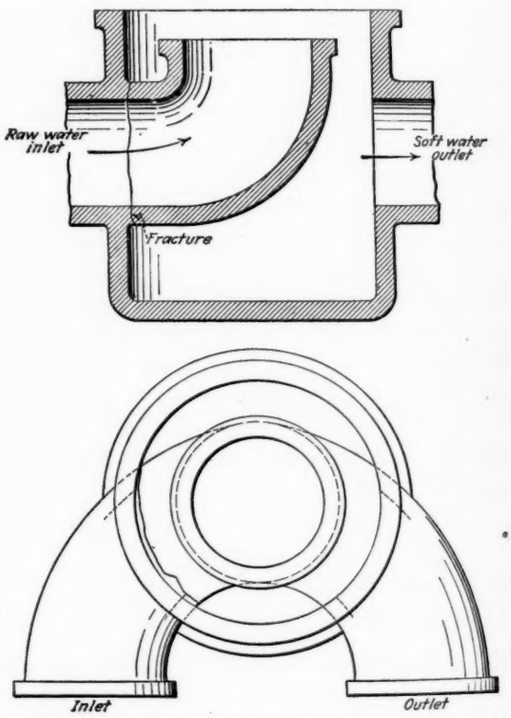
Why the Softener Did Not Work

IN OUR plant, which is a paper mill plant, we operate a base-exchange softener for treating the makeup water. We have a closed system of return on the paper machines, but the steam used in the sulphite mill is, of course, lost and has to be made up.

The softeners had been in operation for about a month and giving satisfactory service. The soap test showed good results. Then, one day, we could not get a satisfactory test.

The first things that occurred to us, were that the mineral bed had become channeled or disturbed or that we were not registering correctly. The system was checked up and found correct. Then we discovered that the softener was not functioning at all, so we decided to take it apart. We sent for a service man, and when he arrived we took out the filter bed and prepared to examine the interior. At this stage the service engineer asked if we were able to get a good flow. We assured him that we could. He said, "Well, try the pressure and see how the sprinklers are working." When we turned on the water, the source of the trouble became apparent.

At the top of the filter tank a cast-iron fitting was screwed on to a close nipple. This fitting was so designed that the inlet water went in at one side and, continuing down, was carried by a piece of pipe to the under side of the sprinkler plate. After leaving the bed, the softened water passed out of the other side of the fitting. The casting was broken at the raw-water connection, and



Fracture in inlet fitting caused water to short-circuit through filter

instead of going through the mineral, the raw water short-circuited and went out the soft-water connection.

A temporary arrangement could have been made by using pipe fittings, but while we were getting it together, the new castings arrived and we put those on. This, of course, cleared up the trouble, and the equipment has been working satisfactorily since. R. G. EDWARDS.

Port Arthur, Ont.

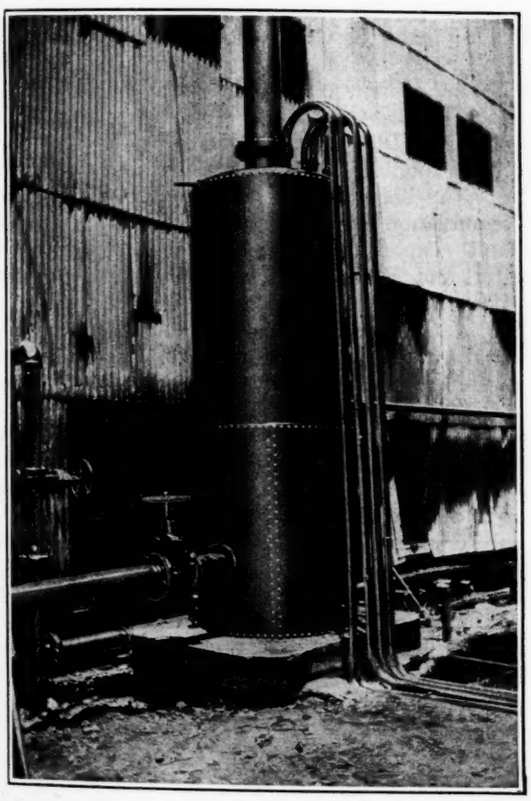
Discarded Boiler Used as Receiver for Steam Trap Discharge

THE illustration shows a receiver for a number of traps made from an old steam boiler that was condemned for operation at the necessary pressure.

The boiler was of the horizontal, return-tubular type. All the tubes were removed from it, and the holes in the heads were plugged with small disks cut from sheet metal and brazed in position in the holes with an acetylene torch. The object of removing the tubes was to increase the capacity of the tank. The hood formerly supporting the smokestack was also detached from the front end and discarded.

A circular hole 6 in. in diameter was then cut in the center of the rear head, and a short flanged nipple bolted on to serve as the vent connection. Beside this hole and near one edge of the head, five holes were drilled and threaded for 1-in. pipe-line connections.

A concrete base was then built outside the boiler room and the old boiler placed on it in an upright position, as shown, with the end containing the pipe nipples upward. The 6-in. pipe extended upward some distance above the roof and served as a vent to carry off the vapor arising from the hot water discharged into it by the traps.



Arrangement of receiver and trap connections

There were five traps in use at this plant, and a 1-in. diameter pipe line is connected to the discharge of each. These five pipe lines extend along the surface of the earth to the base of the reservoir, where they turn upward and connect at the top through return bends as shown. A 3-in. diameter pipe line is connected with the original water cock in the side of the old boiler, and this line extends into the boiler room and is connected with the injectors of the boilers now in service.

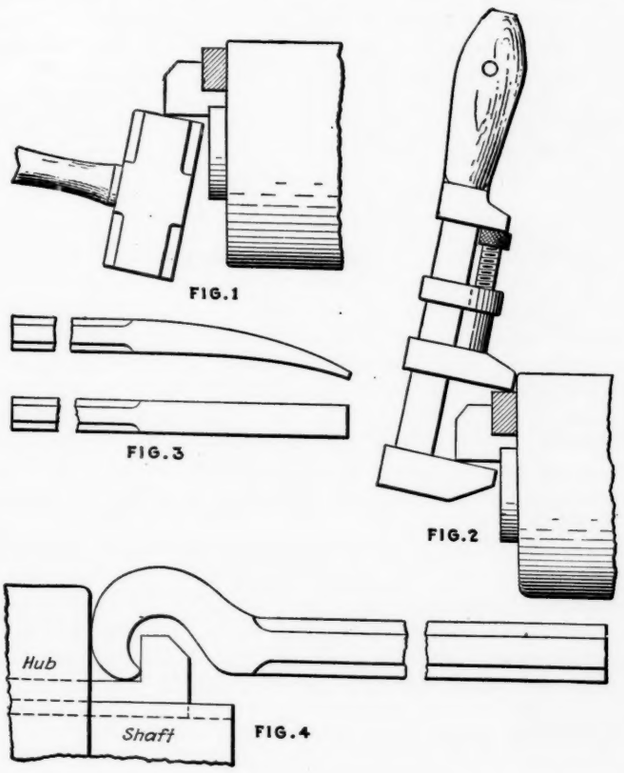
Any form of tank could be used in the same manner, such as old pressure tanks, etc., but this one was fitted up at practically no expense, as the old boiler had been discarded anyway, and the changes necessary were made at leisure in the plant machine shop. The object of erecting it on its end was to conserve space about the plant.

L. M. JORDAN.

Cairo, Ga.

Practical Methods of Drawing Keys

DRAWING keys that have been tightly fitted or have rusted in is often a difficult job. It is frequently easier to drive the pulley or wheel off the key than to draw the key. The application of heat to the hub will make it easier.



Tools for removing keys

With a key in the position shown in Fig. 1, it is usual to hold a sledge under the head of the key to prevent its being bent back by the wedge.

A better plan is to use a monkey wrench as shown in Fig. 2. This prevents the head from being bent back and also keeps the wedge from rising and slipping out.

A key wedge formed as in Fig. 3 with its bottom edge slightly thicker than the top edge to prevent it slipping is a practical tool, and a key puller, shown in Fig. 4, is a useful addition to the power-plant toolroom.

Long Beach, Calif. E. J. JORDAN.

COMMENTS *from* READERS

How the Back Pressure Was Reduced

IN REFERENCE to the article by C. W. Peters in the Dec. 20, 1927, issue on "How the Back Pressure Was Reduced," I fail to see where he gains anything by reducing the back pressure on the engine inasmuch as the demand for exhaust steam is greater than the supply. In reducing the back pressure four pounds, he has lowered the water rate and consequently the amount of exhaust steam leaving the engine. This deficiency in exhaust steam is then made up by expanding additional high-pressure steam through the reducing valve.

Unless there is some condition that he has not explained, it does not seem to me that further expenditures for reducing the back pressure on his engines and turbines would be warranted. W. R. HYDE.

New Haven, Conn.

* * * *

Can Cast Iron Be Bent?

THE interesting questions in each issue of *Power* and the answers to them, which occasionally are not in accordance with the experience of *Power* readers, are a source of pleasure and profit.

Believing that corrections to the answers given are acceptable, I am taking an exception to the answer to question No. 1 in the Nov. 15, 1927, issue, "Can Cast Iron Be Bent," which reads as follows: "In the popular opinion bending means a more or less rapid distortion of a piece of material. In this sense cast iron cannot be bent."

Cast-iron resistance grids suspended under all street and interurban cars when supported at one end, will vibrate up and down like a steel spring of the same cross-section. In fact, I have used cast-iron springs under certain conditions with good success. I think the answer referred to in *Power* is wrong as it stands, and should be amplified. C. E. SARGENT.

Orrville, Ohio.

* * * *

Pulverized Coal Takes Fluctuations in Stoker-Fired Plant

UPON reading the article, "Pulverized Coal Takes Fluctuations in a Stoker-Fired Plant," in the Nov. 15, 1927, issue, it seemed to me that there is a point or two which are misleading. The reader is given the impression that the air flow is measured across the stoker bed. As the depth and condition of the fuel bed must vary with different rates of steam generation, the differential draft across the fuel bed cannot be an accurate indication of the amount of air being used for combustion, but the differential pressure drop across the boiler would be a measure of the air flow.

It would seem from the air-and-steam flow chart that the percentage of excess air is high when the pulverized fuel is not being burned, and I wonder if it would not be possible to carry the full load with the stokers alone without using the pulverized coal, by simply reducing the excess air.

It would have been interesting to have had a chart from a recording CO_2 meter to compare with the flow meter chart.

There is another point I should like to see explained, and that is, How does the excess air for the combustion of the powdered coal come through the stoker bed?

Baltimore, Md. O. CHRISTENSEN.

* * * *

Treating Evaporator Feed

IN THE letter of George C. Reinhard in the Nov. 29, 1927, issue, on the subject of "Treating Evaporator Feed," the contention is made that objections to the presence of scale in boilers apply also to evaporators and that it is just as important to prevent scale formation in evaporators by chemical treatment of the feed water, as in boilers.

Accumulation of scale on heating surfaces on both boilers and evaporators increases the resistance to heat transfer, and in order to evaporate the same amount of water at the same temperature, a higher temperature of the heating medium must be maintained, or if this temperature remains the same, the amount of water evaporated will be less. In a boiler the furnace gases pass out of the stack at a higher temperature, thus losing the heat that cannot be taken up by the water, while in an evaporator with constant steam pressure the amount of water evaporated decreases and the amount of steam required also decreases. Thus, no loss of heat is possible.

Since in an evaporator the amount of steam condensed is proportional to the amount of water evaporation, its efficiency is practically the same at all times, regardless of the condition of the heating surfaces.

Furthermore, an accumulation of scale in boiler tubes shortens their life through higher tube-wall temperatures and adds the menace of shutdowns due to burned-out tubes. Presence of scale on evaporator tubes does not shorten their life, nor can a layer of scale of any thickness cause tube failure.

Removal of scale from boiler tubes is an arduous task and is accomplished only by hand cleaning with the boiler shut down. Evaporators of the best design are self-scaling, and by a simple process of temperature "cracking" requiring from ten to twenty minutes and repeated in the average installation about once each watch, the scale that has collected during the previous operating period is broken from the tubes and blown from the shell.

Briefly, this scale "cracking" process is the sudden admission of live steam to the evaporator tubes with cold water in the shell. This operation appears to be more successful in evaporators in which a pronounced and definite deformation of the tubes takes place during the

cracking process owing to the difference in temperature between the steam and the water. Difference in expansion between the scale and the tube walls is not usually sufficient.

As shown by the foregoing, the three principal objections to scale in boilers do not apply to evaporators. Scale in an evaporator cannot cause a loss of heat or damage the tubes in any manner and can be removed effectively and inexpensively as required to maintain capacity.

OSCAR W. HEIMBERGER.

West Brighton, Staten Island, N. Y.

* * * *

Distribution of Air on Underfeed Stokers

REFERRING to the article by J. J. Croft, on underfeed stoker operation, in the Oct. 18, 1927, issue, may I submit a few suggestions and opinions?

Having once represented a stoker manufacturer, I should like to refer to Mr. Croft's statement about the information given by the stoker manufacturer's representative. It is well to know that the instructions he gives are only general and are not intended to cover fully the customer's conditions. They should be used only as a basis for the customer's own experiments.

Incorrect air distribution causes the fire to become too heavy in some places and too light in others. This in turn causes the fire to become full of holes, and a blowtorch action results, causing the grates to burn out. In

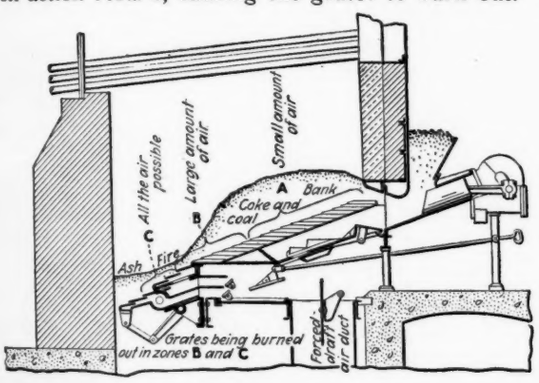


Fig. 1—Plan of air distribution used by Fireman No. 1

the thin section of the fire the grates become overheated, and the ash easily fuses to the grates, burning them out. A fire that is too heavy invariably causes clinkers, and unless they are promptly removed, the grates usually suffer to some extent. A fire should not always be cleaned on schedule, because it seldom gets dirty on schedule. Clean it when it is necessary. The length of stroke on the extension grates should be adjusted so as to just keep the ashes moving away from the incandescent portion of the fuel bed. This will avoid fusion of the ashes considerably.

Referring to Mr. Croft's article and to the illustrations reproduced herewith, I think No. 2 fireman has the best-looking fire; it is well shaped, but should be just a trifle heavier at the front or coking area.

As a great many modern stokers have a common air chamber for the entire grate area, except the extension grates, it is my experience that one of the best methods to regulate air distribution is first to set the forced-draft damper for air required at any given rating, then regulate the thickness of the fuel bed to conform with the air flow required in the front and rear sections of the fire. This is done by adjusting the length of travel on the auxiliary pushers or rams. Once the proper thickness of fire is obtained in these sections to give the best results, the shape of the fuel bed can be maintained practically the same for any rating provided the proper ratio of fuel and air supply is kept.

For ordinary operation 0.3 to 0.5 in. air pressure is sufficient on the extension grates to burn out any combustible in the fuel and ashes carried over them. Shut off the air or extension grates when dumping and use it again when the fire is again normal in that section. To cover the lower portion of the grates after cleaning, increase the extension-grate travel for a few minutes.

As the total air for combustion is seldom if ever supplied through the fuel bed, the furnace should be designed for air admission over the fire. This should be

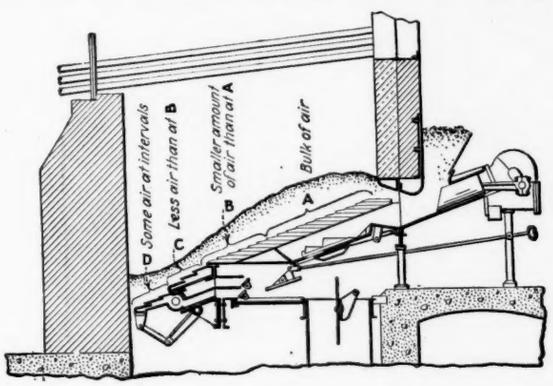


Fig. 2—Plan of air distribution used by Fireman No. 2

under control so the operator can regulate it for proper combustion of gases.

Grates are often burned out when a boiler is taken off the line for repairs, etc. This is sometimes caused by burning out the fire after the stoker feed and stoker mechanism are shut down.

I have used the following method with the result that the grates in no way suffered: First, shut off the air supply under the grates, feed in coal for a few revolutions of the stoker crank. Then shut down the stoker, letting the fire remain at rest for about an hour. This allows the ashes and clinker next to the grates to cool to such an extent that when the air is again supplied slowly and the fire gradually burned down, they will not again reach the point of fusion.

R. S. YOURISON.

Providence, R. I.

I AM inclined to agree with Mr. Croft that the method of air distribution as shown in Fig. 2 is the correct one. It has been our experience that, when the main damper is closed tight, the fire tends to work down to the grates and burn them. In operating our stokers, we endeavor to maintain the highest air pressure in the first zone and taper down toward the rear of the stoker. If Mr. Croft had draft gages and a CO_2 recorder, to fire by, he would soon find that the method shown in Fig. 1 was incorrect on account of the excess air passing through the light fuel bed in the second zone.

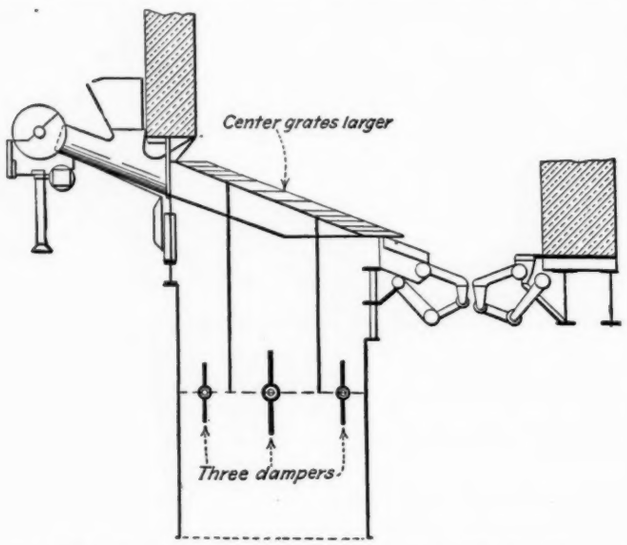
Muscatine, Iowa. LUNN C. ALLEN.

Improving the Distribution of Air on Underfeed Stokers

SOME time ago I read an article in an engineering magazine describing a test made on a traveling-grate stoker to find out what part of the fire had the most carbon monoxide. This condition was found about the center of the fire. To overcome this condition partly the stoker was made with compartments so as to force more air through the center of the fire. Now this same condition will apply to the multiple-retort underfeed stoker.

To overcome this trouble, I have designed a stoker with a series of dampers and larger center tuyeres. This arrangement can be used both together or separately.

I have observed, when firing certain types of underfeed stokers, that they blow the coal onto the wall, dump



Multiple dampers and larger tuyere blocks give better distribution of air

doors and up in the combustion chamber. This causes clinkers to form on the wall, dump doors to bridge over and tubes to slag.

With the arrangement of dampers shown in the illustration, the pressure and volume of air in the first compartment can be cut down so coal will not blow. When coal first comes in contact with heat, it generates or gives off its volatile matter. This does not need much air up through the grates or tuyeres, but needs air admitted over the fire to consume the gases.

When the combustibles are near the center of stoker, they are caked or coked to such extent that they will not blow the combustible against the wall or up in the combustion chamber. Under these conditions there can be a greater pressure and volume of air admitted through the center compartment to overcome the highly concentrated area of CO or carbon monoxide.

I have also observed that an excess amount of air is admitted through the rear end of the stoker or next to the dump doors. This can be regulated with the third series of dampers, as shown in the illustration. This damper should not be confused with the secondary, or extension, draft that some stokers have.

Cabin Creek, W. Va. PERCY J. CREASEY.

Answers to What Do You Know

The questions are on page 174

Ans. 1.—The total pressure tendency to disrupt the boiler on a girthwise direction is $\frac{\pi d^2 p}{4}$ and this is resisted by metal of a length equal to the circumference πd and a thickness t, or the unit stress is $\frac{dp}{4t}$. The total pressure per inch length tending to disrupt the boiler in a lengthwise direction is dp, and this is resisted by two thicknesses of metal, making the unit stress $\frac{dp}{2t}$. By inspection it is seen that the stress in a girth direction is but one-half the longitudinal stress. The removal of a given part of the resisting section weakens the boiler less when the section is taken girthwise.

In addition, from a practical point of view, it is easier for a man to get through the opening if the major axis is so placed.

Ans. 2.—No. At the equator the mercury weighs less than at Boston, so assuming the same actual atmospheric pressure, the column will read higher than will the diaphragm gage.

Ans. 3.—According to heating and ventilating engineers, at a room temperature of 70 deg. F., a body will emit 378 B.t.u. per hour.

Ans. 4.—The difference is mainly due to the difference in scavenging efficiency.

Ans. 5.—Staybolts are made hollow for two purposes. In the first place, leakage out of the opening reveals any break in the staybolt. In addition, hollow staybolts on certain water-tube boilers permit the insertion of a steam nozzle for soot blowing.

Ans. 6.—The convex governor is claimed to give a greater lead and a great valve opening at all usual cutoffs. The lead is of advantage inasmuch as the clearance must be filled with steam and if the lead is not considerable the cylinder steam pressure will be much below the boiler pressure at the beginning of the stroke.

Ans. 7.—The Weir-type pump uses steam expansively to some extent. There are, in addition, some small pumps of the crank and flywheel type.

Ans. 8. —This is due to the bridges buckling on account of excessive heat expansion. The high spots should be ground down and the rough spots on the piston smoothed.

Ans. 9.—If the fluid is in the saturated condition, at which the subtraction of any heat would cause the formation of some liquid, it is said to be dry saturated, with a quality of 100 per cent. If in a given amount of the fluid, part is water, the percentage that remains steam denotes its quality; as example, 95 per cent.

Ans. 10.—The first Chicago Power Show was held in 1926.

IT SOMETIMES HAPPENS that an acid burn of the eye is sustained. One should immediately wash the acid-burned area with an alkaline solution made by adding half a teaspoonful of ordinary baking soda (bicarbonate of soda) to half a glass of water, or, in the absence of water, one may put a little of the dry powder into the eye.

Defining the Plant Engineer

His Duties, Responsibilities and Relations with Other Departments

IN A great many industrial plants the responsibility for certain new construction, machine layout, supply of heat, light, power and process steam, as well as other services, and the maintenance of equipment heads up in an individual known as the plant engineer. In other words, he exercises executive control over these services.

In an attempt to define the duties, responsibilities, and inter-departmental relations of this individual, the Plant Engineers Association of Boston has drawn up the accompanying Code, which is comprehensive enough to meet the requirements of the large establishment and at the same time adaptable, to any extent, to the small plant. It represents nearly three years' work of the code committee and has been submitted for criticism to the various managements represented by the Association's membership. It is here reproduced in part.

Organization Charts

The development of a plant engineer's department personnel will vary with the size of the plant.

Chart I is shown to illustrate the outline for an individual manufacturing plant.

Chart II illlustrates an organization plan for a larger manufacturing plant with factories situated in various cities but controlled from a central office.

The function chart illustrates the details of the activities of the plant engineering department. Part I of this chart, here omitted through lack of space, deals with research, development, design and construction. Part II, here reproduced, deals with operation and maintenance. This chart should be used as a guide in developing an organization for a plant engineering department, the duties of which are outlined in the proceeding discussion.

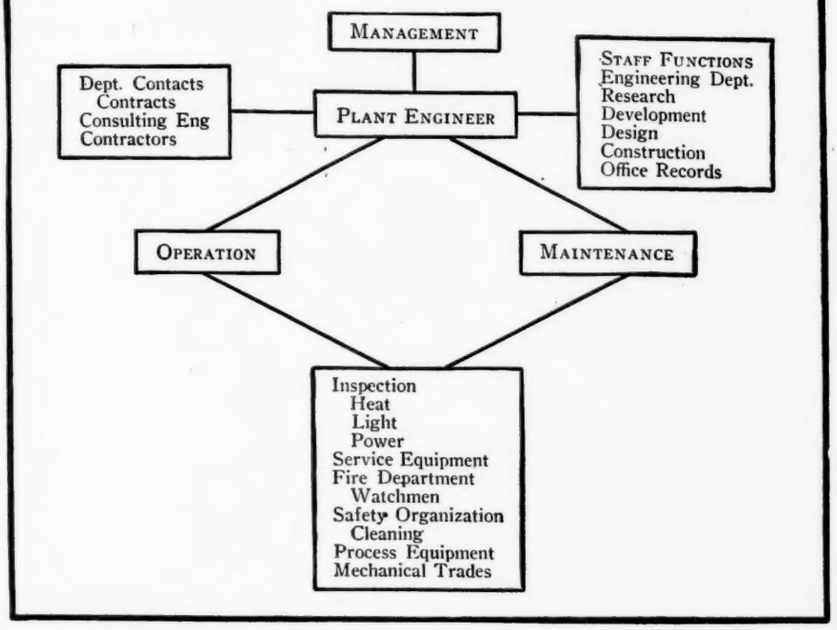
General

The plant engineering department should have full charge of all activities whose successful or economical performance depends largely or entirely upon engineering.

The plant engineering department should be directly responsible to the management.

The extent to which consulting, designing and construction engineers should be engaged, depends upon the character and size of the department under the supervision of the plant engineer. Wherever in these rules it is stated that this department should have jurisdiction over any activity, it means that the work shall be performed by that department or by contract engineers in direct contact with or under the direction of the plant engineering department.

Chart I—The Relation of Principal Plant Engineering Departments
(One Central Plant)



Functions

Research
Development & Designing
Construction
Operation
Maintenance, Repair and Replacements

Research—The plant engineering department should have jurisdiction over all research problems that are dependent primarily upon engineering science and in other problems over those portions which are similarly dependent.

Research work by the plant engineering department upon commodities, equipment or processes that are common to several industries and where reliable data are available is not warranted unless it concerns a special application that is peculiar to a particular industry.

In some industries the term "research" is applied to the investigation of raw materials for the purpose of determining their processing or utilization. This investigation often involves engineering but is somewhat routine in character and more of the nature of testing than of research. This work should be under the control of a special department or the production department.

Development & Designing—The plant engineering department should be responsible for all designs, plans and specifications relating to real estate, structures, power, service and manufacturing equipment. It should be responsible for or consulted upon engineering

features, in so far as they affect the efficiency and cost of methods of manufacture and routing of materials.

Construction — The construction of buildings, structures and equipment as well as all ground work should be under the jurisdiction of the plant engineering department.

Operation—The plant engineering department should have jurisdiction over all operation involved in the manufacture and delivery of heat, light and power.

It should also be responsible for the management and control of all service departments and service equipment.

Maintenance, Repair and Replacement — The jurisdiction of the plant engineering department should include the maintenance, repair and replacement of all real estate, buildings, structures, power, service and manufacturing equipment.

Production Department—1. The plant engineering department should not assume the determination of quantity, quality and time of production.

2. The plant engineering department should provide and maintain equipment for production and be responsible for all problems relating to speeds of operation, temperature, voltage, pressures and general efficiency of machinery.

Note: Service equipment constitutes such utilities as those required for ventilation, refrigeration, elevators, water systems, fire protection, safety engineering and similar functions.

3. The production department should be responsible for the operation of production equipment. The plant engineering department should be responsible for the performance of service equipment and should co-operate with production department in problems relating to handling of materials. All rules and regulations of the plant engineering department relating to safe and economical operation should be maintained.

4. The responsibility for the maintenance of all production equipment except minor adjustments necessary for the operation of machines should be with the plant engineering department.

5. The plant engineering department should be responsible to the management for the safety of structures and safe operation of machinery.

6. The plant engineering department should have authority for supplying heat, light, and power as well as all service systems, within limits set by the management.

7. The plant engineering department should institute a system to facilitate the production department in securing prompt execution of orders.

8. The plant engineering department should co-operate with the production department in planning maintenance work so that it will interfere as little as possible with production. . . . . .

Accounting Department—1. The accounting department should, when possible, supply accounts based upon such classifications as the plant engineering department may require.

2. The plant engineering department should define the classification of any labor or materials used on any work performed under its supervision.

3. The plant engineering department should be consulted as to life of any building or equipment, so far as it concerns any phase of depreciation problems.

4. The plant engineering department should approve all charges for work done by its department before sending them to production or other departments.

5. The accounting department should provide detail reports upon the cost of jobs when they are required by the plant engineering department.

6. The plant engineering department should initiate all records for material and labor which are used in figuring costs of work done by its department.

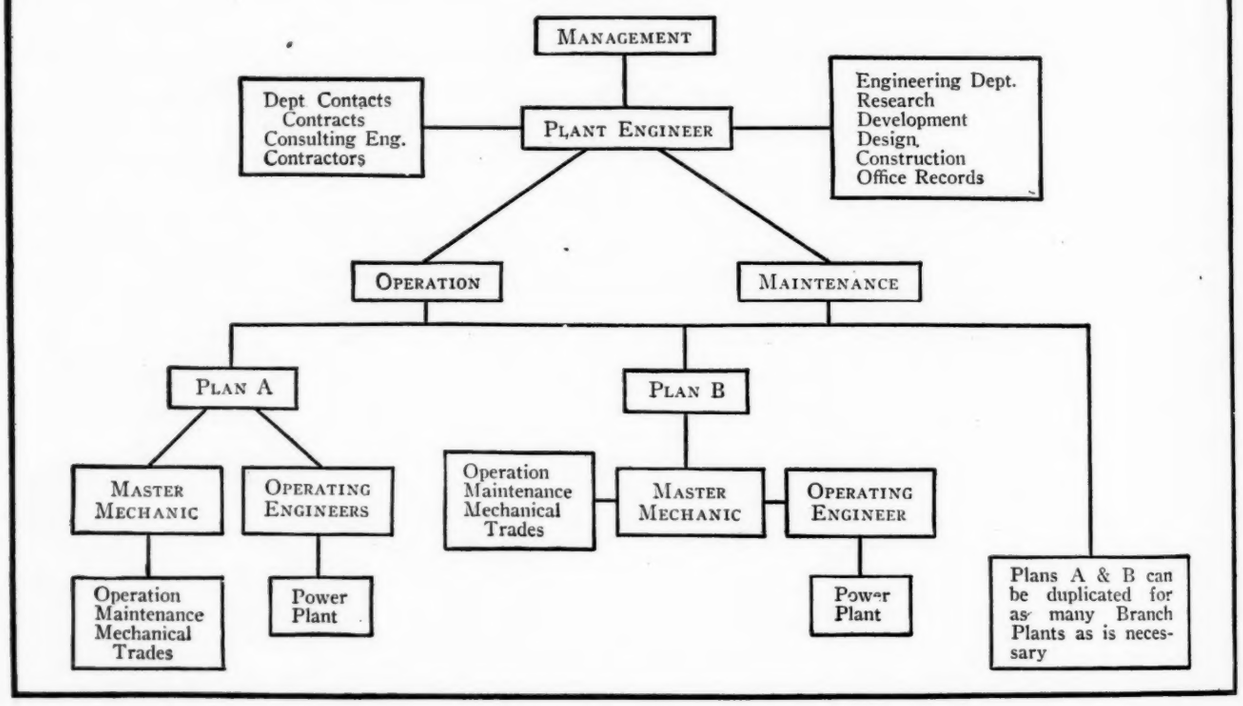
7. The plant engineering department should advise whether charges are to be made against improvements, repairs, expenses, replacements.

8. The accounting department and the plant engineering department should co-operate in the preparation of figures for the distribution of expenses for heat, light, power and service accounts.

9. The plant engineering department should accumulate such comparative data as may be necessary to show economic results from one period to an-

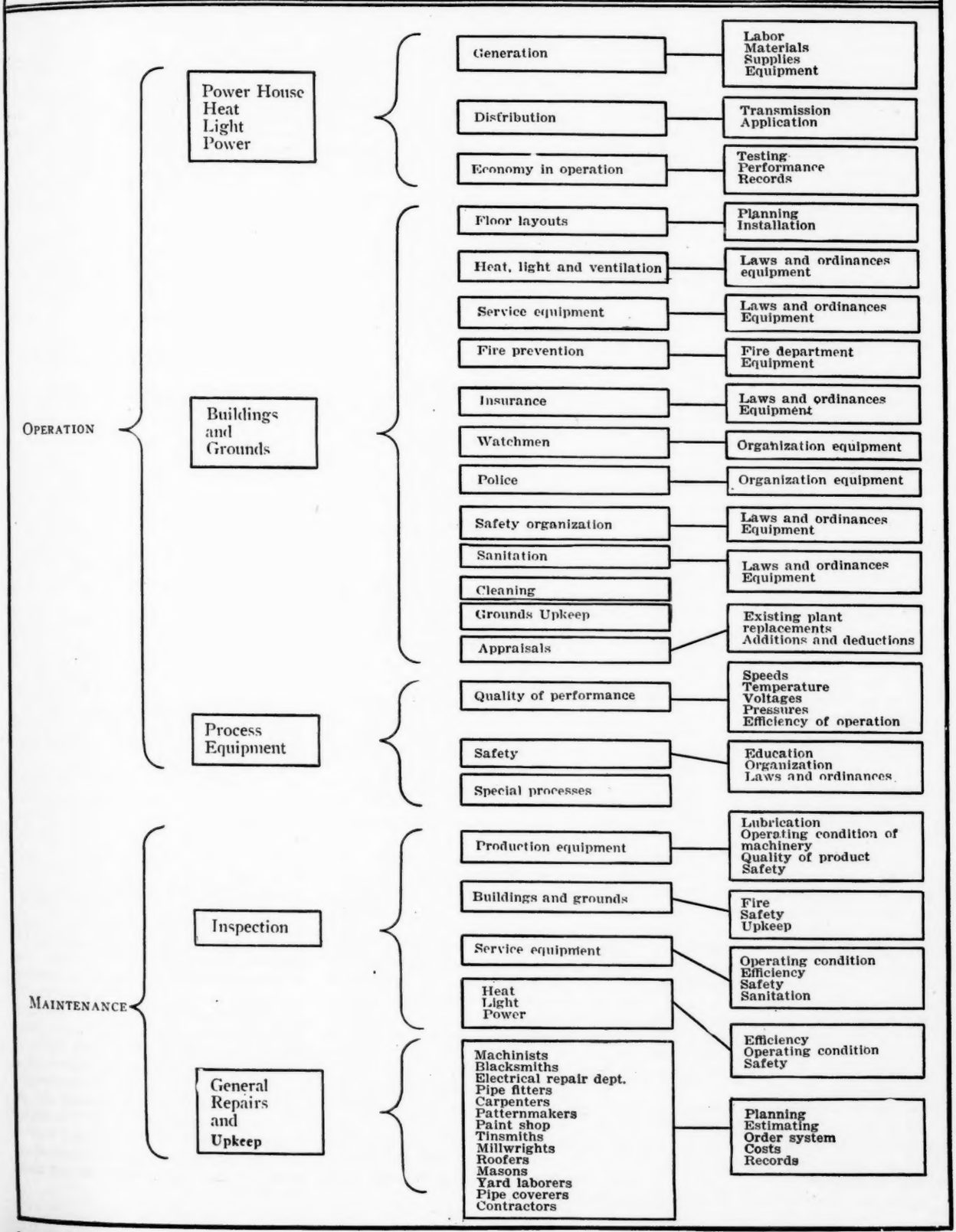
Chart II—The Relation of Principal Plant Engineering Departments

(Branch Factories)



Part II Function Chart of Plant Engineers Department

Recommended by Plant Engineers Club, Tremont Temple, Boston, Mass., 1928
(Designed by Plant Engineers Club of Boston, Mass., 1927)
(Continued)



other and also for comparison with other industries.

10. The plant engineering department should be permitted to check any charges made against accounts for which it is responsible.

11. Appraisals should be made in conjunction with the plant engineering department.

12. Records of changes in inventory values and depreciation of plant and equipment should be supplied to the accounting department by the plant engineering department.

Purchasing Department — 1. The plant engineering department should initiate all requisitions for all supplies and equipment for which it is responsible.

2. The plant engineering department should draw all specifications for and approve all materials furnished upon its requisitions.

3. Major or specialized equipment should be selected by the plant engineering department, but co-operation with the purchasing department should exist in the handling of records and contracts.

4. The plant engineering department should be responsible for all mechanical stores whose supplies should be ordered through the purchasing department.

5. The purchasing department should co-operate with the plant engineering department in the exchange of information or catalogs on new developments or source of supply of materials or equipment.

6. The plant engineering department should co-operate with the purchasing department and suggest possible sources of supply of material and equipment and should be permitted to obtain prices and information when it may seem advisable. In case of abnormal conditions where price is secondary, the plant engineering department should have the authority to determine the purchase of materials and equipment.

7. The plant engineering department should check and report all goods received on its order for quantity and quality and should make such tests as are necessary and report to the purchasing department when requested as to the results obtained.

8. The plant engineering department should prepare contracts and receive bids on all construction, power purchases or other allied service.

Insurance Department—1. The plant engineering department should be responsible primarily for the reduction of hazards and secondarily for the reduction of rates for insurance. . . . .

The plant engineering department should be provided with all schedules used in calculating insurance rates and make such recommendations as would reduce insurance premiums.

The plant engineering department should assist in all problems on employees' liability insurance, in so far as related to inspection, engineering and accident prevention.

Consulting Engineers—1. The plant engineering department should be permitted, with the approval of the management, to call upon a consultant when additional professional advice is necessary.

2. All engineering data furnished to the consulting engineers should be provided by or approved by the plant engineering department.

3. The plant engineering department should be consulted upon the selection of the consulting engineer and act as the management's agent in relations with him.

4. The result of any investigation made by consultants should be submitted to the plant engineer for his comment or approval prior to definite action by the management.

Contractors—1. The plant engineering department should prepare for the management and legal department all major contracts for engineering work, purchase of equipment and the erection and maintenance of structures.

2. The plant engineering department should check and approve all plans, specifications and contracts before the award of same.

3. The plant engineering department should have a sufficient knowledge of law to protect the owners' interests in all contracts either written or implied, and to interpret the responsibility of principal and agent; also, to interpret the performance of engineering work so far as it is regulated by contracts and specifications. . . . . .

5. The plant engineering department should submit to the management for approval, a list of bidders with recommendations, for the award on all major contracts.

6. The plant engineering department should be responsible for the carrying out of all construction contracts according to plans and specifications. . . .

9. The plant engineering department should be responsible for all guarantees and performance tests which may be required under the terms of the specifications or contracts.

10. The plant engineering department should check and approve all bills for contract work prior to settlement by the management.

Legal Department — 1. The plant engineering department should obtain the advice of the legal department on all special problems pertaining to law.

2. The plant engineering department should have a general knowledge of federal, state and municipal laws and ordinances in connection with his work. Copies of the state laws on such questions as boiler inspection, elevator operation, toilet facilities, storage of inflammable materials, etc., should be kept in the file. . . . . .

5. The plant engineering department is directly responsible for compliance with the many laws controlling manufacturing, such as maintaining proper entrances and exits, adequate washing facilities, good sanitary conditions, well-lighted rooms, etc.

6. It shall assume the responsibility of making sure that all employees on building, power and maintenance work are properly licensed, including engineers, firemen, elevator operators, plumbers, etc.

Other Departments — 1. The plant engineering department should co-operate and carry out recommendations with the personnel department on all problems which may develop in relation to accident prevention, recreation, medical matters and employment.

Other Plants—1. Members of the plant engineering department should, with the management's permission, keep in touch with other plant engineers. They should have the opportunity to visit other plants in order to become familiar with modern methods and engineering practice.

2. They should compile comparative data and measure such results with other companies as may be of material interest, in so far as agreeable to management.

Super-Excitation to Protect Conowingo System

FAST excitation of a new order will be used with synchronous condenser equipment soon to be installed for the Philadelphia Electric Company at is new Plymouth Meeting substation, the tie-in point between the 220-kv. Conowingo line and the network of the same voltage covering Pennsylvania. The condensers will be rated at 30,000 kva., but will normally operate at only one-third capacity.

In order to increase the power carrying limits of this interconnection during system short circuits, super-excitation will be used on the condensers, by means of which their output will be increased six times to approximately double full-load rating in about one-half second. The condensers operate at 13,800 volts and will be connected to third windings on the power transformers. A direct-connected main exciter and sub-exciter, controlled respectively by an alternating-current and a direct-current voltage regulator, will raise the field voltage on each condenser to a maximum value of about 1,000 volts at the unprecedented rate of 6,000 to 7,000 volts per second.

Super-excitation was adopted by the Philadelphia Electric Company as the best means of providing increased stability on the 220-kv. lines during system disturbances. The equipment was designed and will be installed by the General Electric Company. It is an interesting example of the high limit to which excitation can be pushed in a special case, but is not, the company's engineers point out, a panacea for all system disturbances. Nor, can super-excitation be employed without accepting the consequent disadvantages of increasing the current flow during short circuits.

Record Attendance at Meeting of Heating and Ventilating Engineers

DURING the week of January 23 the American Society of Heating and Ventilating Engineers held their thirty-fourth annual meeting at the Pennsylvania Hotel, New York City. The meeting was marked by the largest attendance in the history of the society. In addition to many committee reports, there were presented twenty technical papers on a large variety of heating and ventilating subjects, many of which are of interest to *Power* readers.

At its annual dinner and dance held Tuesday evening, J. I. Lyle presented the past-president's emblem to F. Paul Anderson, the retiring president. Senator A. O. Stanley of Kentucky, the main speaker of the evening, paid tribute to Benjamin Franklin, who is the patriarch of the association. Among Franklin's many diversified activities he was a pioneer in the promotion of the art and science of heating and ventilating.

Other entertainment arranged by the Metropolitan section was an inspection trip through the Holland Vehicular Tunnel and a trip to the Brabee Thermal Laboratories at Mount Vernon, N. Y. The trip through the tunnel under the Hudson River was of great interest as it contains one of the most difficult ventilating undertakings. The Thermal Research Laboratories were of equal interest, as in this laboratory many new things about radiation are being discovered.

Methods of Testing Radiators

At the first technical session, held Monday afternoon, two papers were presented relating to methods of testing radiators. The paper by C. W. Brabee advocates the testing of radiators so that they will be rated according to the amount of steam required to produce a condition of comfort under definite conditions of outside temperature. The tests have been carried on in two identical test rooms, where the radiator tested is compared with a standard radiator. The temperature surrounding the test rooms is maintained at the freezing point. The temperatures in the test rooms are measured one and a half feet above the floor and are maintained at 70 deg. by installing a radiator of proper size. Tests of this nature have shown that a radiator of one type will produce a condition of 70 deg. at knee height when condensing 7.9 lb. per hour, whereas a radiator of a different type requires the condensation of 16.3 lb. per hour in order to produce the same condition of comfort. The increased steam consumption is explained by the higher ceiling temperature existing in the case of the less efficient radiator.

The paper by F. C. Houghton and S. R. Lewis reviewed several methods that have been used for testing radiators and, from the analyses made, arrived at the characteristics desirable for an ideal test room. These conclusions may be summarized in that an ideal test room should make possible the testing of radiators of various sizes, should not be subject to excessive or unnatural air currents, and the temperature through the walls should be normal. The paper includes a description of a proposed test room that would meet these conditions.

These two papers brought forth a considerable amount of discussion. F. C. Houghton expressed the opinion that there was as yet insufficient evidence to warrant rating one of the radiators cited in the paper by C. W. Brabee more than twice that of the other. It was felt that the location of the radiator in the room, the size and shape of the room, and the relative window area might change the relative performance of the two radiators in question. Other discussion brought out that the same radiators tested in different rooms, when emitting the same number of B.t.u. per sq.ft. per hour produced radically different room temperatures. Mr. Hart expressed the opinion that in large offices radiators emitting large amounts of radiant heat were highly objectionable.

Discussion by Prof. E. H. Lockwood indicated that in an actual building the heat loss due to a 10-deg. higher ceiling temperature would cause an increased heat loss of only 5 per cent. This is considerably lower than the saving claimed in the Brabee paper through keeping a more uniform temperature between ceiling and floor.

Addresses by S. R. Lewis, Dr. S. W. Stratton and H. L. Whitelaw stressed research and the work being done to obtain co-ordination in research. By co-ordination in research was meant the helpful guidance of the research efforts of the many university laboratories toward those researches that would be most helpful to the field of heating and ventilating.

Schoolroom Ventilation

A session was devoted to the ventilation of schoolrooms, and three papers were given on this subject. S. R. Lewis presented a paper in which he described a rational arrangement where results could be obtained either when using windows for fresh air supply or when using a supply of unheated air from other sources than windows in classroom ventilation. The result of a study conducted by the New York Commission on Ventilation during the period of the school year 1926 to 1927 was presented by T. J. Duffield. This study compared the health of school children in schools having a mechanical system of ventilation as against schools using the open window method of ventilation.

The third paper, by W. R. McCormack, described the application of unit heaters to schoolroom ventilation in the Celendonia School in East Cleveland, Ohio.

Discussion brought out that failure of mechanical ventilating systems in schools was quite frequently due to the persistent failure of operators to operate the system as designed. In this connection it was suggested that the Society undertake the preparation of an operating code to which the various school commissions could turn for assistance. It was the general belief that the many factors and variables involved in the study by Duffield did not yet warrant any real conclusions to be drawn.

In a paper, "What Will the Engineer Choose, Heating Only or Air Conditioning for the Modern Plant?", H. P. Gant presented a comparison of the first cost and operating expense of various types of heating and air conditioning systems for industrial plants. The comparison considered six primary types of systems, all applied to the same plant building. The systems considered were, heating with direct radiation, heating with suspended type unit heaters, heating with floor type unit heaters, humidifying with spray heads, and heating with direct radiation, humidifying with heating and central air conditioning systems, and humidifying and heating with self-contained air conditioning units.

In all the calculations the building was assumed to be heated to 70 deg. F. in zero weather, with 5 lb. steam pressure and a gravity return. For the various conditioning systems it was assumed there would be a connected load of 151 hp. in motors in the main room, as well as 75 employees. A relative humidity of 65 per cent was assumed to be required in the room throughout the year.

For each system the fuel required per season, wages of operators, maintenance, electric current, and interest on first cost of system were calculated. A table was included, showing a summary

of the operating expense and estimated first cost of each of the systems considered.

The many other factors that should be considered, such as adaptability, flexibility of control, ease of expansion, portability, salvage value, conservation of floor space, obstruction of light and time required to make the installation were discussed in some detail.

In discussing the paper, J. N. Frank presented what he considered a better arrangement of unit heater. He suggested using five units of 600,000 B.t.u. capacity, instead of the arrangement in the paper, where 15 units of 200,000 B.t.u. capacity were considered.

In commenting on the paper Mr. Carrier remarked that design of a central system must necessarily be radically different if cooling in the summer time was to be part of the duty of the system. Mr. Niles pointed out that the author had not included in the comparison a consideration of hot air furnace systems, and that he would undertake the preparation of data for use in comparing this system with the other systems considered in this paper.

In presenting his paper on "Dairy Stable Ventilation," F. L. Fairbanks showed an interesting demonstration of how the actual air currents of various types of stable ventilation had been studied. Cross-sections of various types of stables were displayed in which electric light bulbs were arranged to simulate the heat given off by the cattle in the stable. By introducing the white fumes of ammonium chloride through the inlet openings the paths taken by the fresh air could easily be traced.

The apparatus used for producing the ammonium chloride fumes was quite simple and consisted of two concentric dishes in one of which was placed some ammonium hydroxide, and in the smaller dish was placed hydrochloric acid. When these two dishes were placed one inside the other, the fumes of the two chemicals mixed to form the white smoke of ammonium chloride. This arrangement allows the production of a traceable smoke which has no initial velocity and does not require the presence of an operator who may interfere with the natural air currents.

The studies resulted in the development of a satisfactory stable ventilation system in which the entering air was admitted at the stable wall, and floor outlets located where dictated by constructional convenience provided for exhaust.

In commenting on the paper, A. C. Willard said that studies of air currents in rooms due to various types of radiation were being made, using the ammonium chloride fume apparatus developed by F. L. Fairbanks.

Natural Ventilation of Industrial Plants

Wind is the chief motive force utilized in the aëration of a building by natural means. It forces air in by way of certain openings, through the building and out by other openings. If the building is one in which heat is produced, and in practically all buildings this is true, the warm air inside has a tendency to rise, due to its buoyancy, and this also assists in the aëration. These two forces may aid or oppose each other, and it is essential that they be co-ordinated and controlled, and the air changed in the zone of occupation if the building is to be successfully aërated. In the paper, "Aëration of Industrial Buildings," W. C. Randall presented a thorough and fundamental study of the factors involved. It included the testing of models in the laboratory and the correlation of these results with field tests. This paper should prove of great help in the design of industrial buildings.

Corrosion in Steam Heating Systems

The paper by F. M. Steller, on "Corrosion in Steam Heating Systems," discusses a subject of great importance to the engineers operating heating systems in many localities. Corrosion in heating systems is confined mainly to the return pipes and is largely due to the presence of dissolved oxygen and carbon dioxide. The carbon dioxide in the condensate comes mostly from the dissociation of bicarbonates or carbonates in the boiler, and for this reason it is suggested that sodium carbonate not be used for treatment of feed water in heating boilers. It was suggested that oiling the steam would afford substantial protection to the steam and return piping. In the discussion, however, it was questioned whether this would be advisable, because of the danger of getting oil into the boiler with the returned condensate. A discussion by J. H. Walker related the experience of the Detroit Edison Company with zeolite, and acid treatment of feed water in their new Beacon Street plant. A more detailed abstract of this paper will be published in an early issue.

Testing Low-Pressure Steam Heating Boilers

Two papers were presented relating to the testing of low-pressure steam heating boilers, both of which were intended to provide information that would be of assistance to the committee that is preparing a code for the rating of low-pressure steam heating boilers.

The paper by L. F. O'Bannon gave the results of tests intended to show the relative accuracy of test results obtained by delivering the steam to a condenser and weighing the condensate, and by weighing the feed water to the boiler, which requires that the boiler level be the same at the end of the test as at the beginning.

The results of tests made by the U. S. Bureau of Mines for the purpose of obtaining data to show the relation that exists between some of the operating characteristics of low-pressure steam heating boilers were given in a paper by P. Nicholls.

The tests were made on two cast-iron boilers, one a horizontal sectional boiler having 32.5 sq.ft. of grate area, and the other a round sectional boiler having 3.14 sq.ft. of grate area. Curves are presented in the paper, showing the relation between output and various factors, such as flue-gas temperature, per cent CO_2 in the stack gases, boiler draft, together with other curves showing an inter-relation between these factors. A more detailed abstract of both of these papers will be published in an early issue of *Power*.

In accepting the report of the Committee on the Rating of Low-Pressure Boilers, it was decided to change the name of that committee to the Committee on Rating and Selection of Low-Pressure Heating Boilers. This action authorizes the committee to prepare such codes as may be necessary to help in the selection of heating boilers.

A standard test code for heat transmission through walls was tentatively accepted by the Society. The code is divided into three parts: Part I contains definitions and formulas, Part II deals with the conductivity of homogeneous materials, and Part III relates to overall heat transmission.

In discussing the code, Professor Angus suggested that it include an approximate method of testing as well as the accurate method described. It was his opinion that the duration of tests as called for in the code was too short and that the location of thermocouples should be more definitely specified. He also pointed out that in Part II the code called for testing at a mean temperature of 60 deg., while in Part III it specified a mean temperature of 40 deg. These mean temperatures, it was suggested, should be made to agree.

At the suggestion of W. H. Carrier it was decided to submit the code to the heat transfer committee of the National Research Council for the purpose of securing the co-operation of the American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Institute of Architects and the Canadian Institute of Architects, in an endeavor to make this code standard with all societies interested.

Ole Singstad, chief engineer of the Holland Vehicular Tunnels, presented some interesting data on the operation of the tunnels. During the first day of operation 52,000 cars passed through them, and the maximum rate yet attained is 2,300 cars an hour.

Analysis of the air in the tunnels during the time of maximum traffic showed that it contained between 132 and 157 ppm. of CO. Analysis of the air in certain New York streets has shown as much as 282 ppm. of CO, or nearly double the CO content of the air in the tunnels, showing the excellent ventilation that has been provided.

The tellers reported that A. C. Willard had been elected president of the Society; Thornton Lewis, first vice-president; L. A. Harding, second vice-president; and W. E. Gillham, treasurer.

NEWS *of the* FIELD

Reports Favorable to Hydro-Electric Development of Boulder Canyon Submitted to Interior

Garfield, Former Secretary, Discusses International Phases—Professor Durand Sees No Great Over-all Reduction in Steam Production Costs

INDIVIDUAL reports, highly favorable to the hydro-electric development in Boulder Canyon, have been submitted to the Secretary of the Interior by his special advisers on the development and control of the Colorado River.

An outstanding feature of the report by James R. Garfield, a former Secretary of the Interior, is his discussion of the international phases of the Colorado River problem. Prof. W. F. Durand, of Leland Stanford, supports the existing estimates of cost and expresses the opinion that there seems no reasonable ground for anticipating an over-all reduction in steam production cost greater than 0.05 cent or 0.07 cent. Among Doctor Durand's conclusions are the following:

CONDITIONS IN SOUTHERN CALIFORNIA

"Cities of southern California, of which Los Angeles stands as a chief example, are facing the need of large additions to their present water supply or, failing in such addition, they face restriction or limitation to the growth which they believe their agriculture, industrial and climatic conditions generally, entitle them to anticipate.

"Troubles, disadvantages and possible menace incident to the present system of water supply for the Imperial Valley may be obviated by the construction of a canal entirely upon United States territory.

"The construction of such a canal is a practicable engineering project, and its operation and maintenance do not promise any difficulties of a serious or controlling character.

"The use of available sites on the river for power development will result in the provision of electric power in large amounts and at costs which will permit of its transmission to power markets for sale at figures showing a margin of advantage over power supply from other present available sources.

"It will provide at the top of the reservoir as 'active' or draw-down storage, a capacity of 8,000,000 to 10,000,000 acre-feet, which will control all floods except the most unusual and which may be anticipated only at long intervals of time, to a maximum discharge of 40,000 sec.-ft.

"The territory within economic transmission distance for electric power from the Black Canyon will provide a power market sufficient to absorb the entire power developed at this site within two or three years from the completion of the project; and under these conditions and under such prices as may be anticipated from competitive sources (so far as can be now foreseen, the economic soundness of the project and its capacity to pay out will be assured."

NO INTERFERENCE BUT AID TO ALL

In his report Mr. Garfield states that "The Federal Power Commission, which, under the general act of Congress, would have jurisdiction to grant a license for the construction of a dam for power purposes, is prohibited, by the joint resolution adopted March 4, 1927, from issuing or approving a license affecting the Colorado River or its tributaries until and unless the compact has been approved by Congress, or, in the event that the contract is not sooner approved, until March 5, 1929."

Mr. Garfield's report disclaims "that the construction of a power plant of the magnitude suggested in this instance of the development of the Imperial Valley through a canal system simultaneously benefiting Mexico is an improper interference with the vested interests of private power companies. The United States Government does not propose to enter into the business of the distribution of power, but proposes merely to sell power at the switchboard in large units to either public authorities or to private companies at a price merely sufficient to cover the cost of construction.

"Furthermore, the problem is no different from that which would arise whenever a private company enters upon a new power development. It is to be remembered that private companies have expressed their willingness and have taken first steps toward the construction of a dam at Boulder site and other sites along the river. Surely, the government should not be precluded from utilizing its own property for the benefit of all the people within the area affected because of the fear that such utilization might interfere with some existing properties. The same argument might be used regarding all existing properties.

"It is the opinion of eminent constitutional authorities that the Congress of the United States, through its constitutional prerogative of regulating commerce among the several states, has full authority to construct such works of river control without further permission from the interested states. The Supreme Court of the United States has held that such constitutional authority carries with it the power to control and equate the flow of navigable streams such as the lower Colorado River. While the beds and banks of a navigable stream are owned by the state through which the stream flows or by the states abutting upon such stream, and while the states have sovereignty over the waters within and upon their borders, they cannot use such title and sovereignty to prevent the Congress of the United States from exercising a constitutional authority that has been specifically delegated to it by the states. The right of the United States government to construct works of control does not appear to carry with it the right to allocate the unappropriated waters of the Colorado River to the interested basin states. Such allocations should properly be made through compacts between the interested states, approved by Congress."

Utility Economics Course for Harvard Summer Study

"Public Utility Management and Economics," in charge of Prof. Philip Cabot, and Deane W. Malott, instructor in public utility management, a course given last summer, with 35 public utility executives from all parts of the country, will be included by the Harvard Business School in a special session for business executives to be given during the coming summer, July 9-Aug. 18.

The following subjects will be available: accounting policies; business policy and the law; finance; marketing, sales management, and advertising; marketing, retail store management, and advertising; public utility management and economics; and railway transportation.

Each course will require the full time of the student, and classes will meet for four hours daily.

November's Record High in Electricity Output

THE average production of electricity throughout the country during the month of November was 228,700,000 kw.-hr. per day, an increase of about 3 per cent over the daily rate for October according to an announcement by the United States Department of the Interior. This increase is an indication of a positive improvement in the demand for electric power during November, as compared with October. In this connection, it is of interest to note that the daily output for November was the largest daily rate at which electricity was ever produced for public use.

The figures of output for the period January to November (11 months) of this year indicate that the total output of public-utility power plants for 1927 was about 79,700,000 kw.-hr., an increase of about 8 per cent over the total output for 1926.

Total monthly production of electricity by public-utility power plants in 1926 and 1927 as given by the Department of the Interior follows:

The quantities given in the tables are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations and electric-railway plants. Reports are received from plants representing over 95 per cent of the total capacity. The output of those plants which do not submit reports is estimated; therefore the figures of output and fuel consumption as reported in the accompanying tables are on a 100 per cent basis.

			Per Cent Increase, 1927	Produced Power 1926	By Water (Per Cent) 1927
January	6,159,000,000	6,730,000,000	9	32	35
February	5,629,000,000	6 080,000,000	8	34	36
March	6,178,000,000	6,717,000,000	9	37	38
April	5,812,000,000	6,416,000,000	10	40	40
May	5,849,000,000	6,582,000,000	12	40	41
June	5,920 000,000	6,475,000,000	9	38	39
July	5,955,000,000	6,455,000,000	8	34	38
August	6,175,000 000	6,684,000,000	8	34	36
September	6,221,000,000	6 607,000,000	6	33	33
October	6,594,000,000	6,928 000,000	5	33	34
November	6,482,000,000	6,860,000,000	6	35	36
December	6,817,000,000	.....	..	35	..
	73,791,000,000			35	

Demonstrates Industrial Fire-Fighting Equipment

An exhibition and demonstration of the Phomene accumulator system of fire-fighting equipment was given in Newark, N. J., by the Globe Automatic Sprinkler Company, and the Pyrene Manufacturing Company on the afternoon of Jan. 19. The demonstration consisted of automatically extinguishing fire in a 30-ft. tank of oil, in a lacquer spraying booth and in a enamelling dip tank.

The most spectacular part of the demonstration was the 30-ft. tank of oil which was ignited and allowed to burn for about 10 minutes. Then the fire-fighting equipment was brought into action, and in two or three minutes a blanket of foam was formed over the oil that completely extinguished the fire. Although the other fires were not as spectacular as the oil tank, the efficiency with which they were handled indicated the effectiveness of the system in extinguishing fires.

The Phomene accumulator system consists of a tank containing a white powder which is connected to the water system, through an automatic valve, and to the object to be protected. When the water is turned into the powder a foam is formed that flows through a foam-distribution system, over the object on fire. The fire is extinguished by the foam blanket excluding the air from the combustible. Various methods may be employed for making the system automatic, such as sprinkler heads and thermostatic devices.

Andrews-Bradshaw Company Merges With Blaw-Knox Concern

Merger of the Andrews-Bradshaw Company, Pittsburgh, with the Blaw-Knox Company was announced Jan. 19. The Andrews-Bradshaw Company is a Pennsylvania corporation whose main offices are in Pittsburgh, with representatives in many parts of the United States and foreign countries. The principal product of this company is known as the Tracyfier, a device for thoroughly cleaning steam, gas, air and vapor, which is being widely used in boiler plants, refineries, gas plants, etc.

No change in the organization of the Andrews-Bradshaw Company is contemplated with the exception that the products of this company will be manufactured in the main plant of the Blaw-Knox Company at Blawnox, Pa. The Andrews-Bradshaw Company will operate as the Andrews-Bradshaw division of the Blaw-Knox Company.

This merger gives to the Blaw-Knox Company an additional product for the power plant field, in which the company is already well represented through its air preheaters, standard steel buildings, clamshell buckets, and electroforged steel grating. The Blaw-Knox Company also manufactures steel form for concrete construction, transmission towers and poles, road builders' equipment of all types, equipment for water cooling high temperature furnaces, apparatus for automatically proportioning concrete aggregates, steel bins, general structural and plate work and forge and hammer welded equipment for high pressure services.

Dr. Michael Pupin Receives Washington Award

At a reception and banquet held in the Palmer House, Chicago, on the evening of Feb. 2, the Washington Award for the year 1928 was presented to Dr. Michael Pupin of Columbia University. Founded in 1916 by John W. Alvord, past-president of the Western Society of Engineers, this honor award is annually conferred upon an engineer whose accomplishments have pre-eminently promoted the happiness, comfort and well-being of humanity.

The recipient is nominated by a commission made up of nine members of the Western Society of Engineers and two members from each of the four founder societies, that is, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society of Civil Engineers.

In the exercises of the evening R. F. Schuchardt served as chairman. Rufus W. Putnam, president of the Western Society of Engineers, reviewed the foundation and purpose of the Washington Award. Max Mason, president of the University of Chicago, was the speaker of the evening and his topic "Mathematics and Invention."

It may be recalled that the recipient of the award, Dr. Michael Pupin, professor of electro-mechanics and director of the Phoenix Research Laboratory at Columbia University, in 1892 invented tuned circuits for selective electrical reception of signals and developed the resonant system now used as the basis of all radio broadcasting. Inventions for rectifying alternating current and rapid X-ray photography followed. Perhaps his greatest contribution is the method of loading telephone circuits, without which long-distance telephony would be impossible. During the war he rendered notable service by developing a method of submarine detection using high-frequency sound waves concentrated in a beam like a searchlight, with which he worked out a sensitive amplifier free from internal noises. He has received four scientific prizes and many honorary degrees, and was president of the American Institute of Electrical Engineers in 1925-26.

Recent Water Power Projects Are Authorized

A preliminary permit for the Wisconsin Power & Light Company, covering five sites within the Menominee Indian Reservation in Wisconsin, was authorized by the Federal Power Commission at a meeting held Jan. 18. A license for a power site partly within the reservation was issued this company July 20, 1927. The remaining five sites with a proposed installed capacity of 20,000 hp. has been reported on favorably by the Chief of Engineers and the Commissioner of Indian Affairs.

A license was authorized the Savannah River Electric Company, Greenwood, S. C. It covers 120,000 hp. project on the Savannah River, 220 miles above its mouth.

A license for the Northern Connecticut Power Company was authorized covering a project on the Connecticut River near Windsor Locks. The project involves the construction of two dams, a canal, a lock, and a power house. The installed capacity is to be 49,800 hp. The proposed project will make full use of the power possibilities on the section of the river involved and will improve navigation.

Walter H. Wheeler, of Minneapolis, has applied to the Commission for a license covering a project on Flathead River and lake in Montana. He proposes to develop power at five sites on Flathead River, using Flathead Lake as a reservoir. The aggregate installation at these sites would be 170,000 hp. This application conflicts with one of the Rocky Mountain Power Company.

Timken Plans Wide Expansion of Production Facilities

Announcement has been made by the Timken Roller Bearing Company that an expenditure of $4,000,000 will be devoted during the year to increasing the production facilities of the company. The greater part of this expansion program concerns the company's plant at Canton, where both the steel mill and the bearing manufacturing plant proper will be considerably enlarged. Among other features a new substation of greater kilowatt capacity will be built for supplying electric power for both the steel mill and the factory.

This enlargement of facilities has been rendered necessary by the increased demand for bearings which marked the end of the past year. Several factors have contributed to this increase. Business in the various industrial fields in which the bearings have become established, has decidedly been a determining element. The application to the roll necks of steel mills is constantly growing, as are those to various types of auxiliary equipment, such as hot saws and live rolls. The use of roller bearings in mine cars and similar equipment is steadily becoming more general, showing an increase over the previous year's record. There has been an increasing tendency on the part of paper machine manufacturers to equip their machines throughout with roller bearings and application to railway service has also increased.

Harvard Bureau Issues Study on Interstate Transmission

A study based on a nation-wide investigation of the electric light and power companies engaged in interstate transmission of electric power in the United States has been published by the Bureau of Business Research of Harvard University under the title "Interstate Transmission of Electric Light and Power Companies in 1926."

The total quantity of electric power transmitted across state lines, as reported to the Bureau, aggregated 6,171,530,837 kw.-hr. in 1926, exclusive of power crossing the Canadian or Mexican boundaries. This is approximately 9.06 per cent of the total of 68,145,217,000 kw.-hr. generated by all electric light and power companies in the country. Of all interstate power 26.28 per cent involved no change in ownership, according to the Bureau's report.

In 1926 there were in operation 453 interstate power lines. Of these 152, or 33.6 per cent, were placed in operation during the years 1924, 1925 and 1926.

The aim of the study was to secure complete and unbiased information on interstate power, and was undertaken as a part of the Harvard Business School's general research program for the purpose of providing information for use in teaching.

Dock Power Plant Supplies Ships and Crane

An automatic power plant to supply electricity for the operation of a 350-ton crane, soon to be installed at the navy yard at Puget Sound, Washington, will also supply power for ships berthed alongside the fitting-out pier.

This will be the first installation of its kind to be made by the Navy Department and will mark an innovation in marine practice. Naval vessels, after docking and shutting down their propulsion power plants, will be able to plug in to convenient junction boxes to obtain sufficient electricity for lighting purposes, operating deck machinery and any other requirements which arise when large naval vessels are at the pier.

Two 800-kilowatt, three-unit, direct-current motor-generator sets of General Electric design will be installed to operate with full automatic equipment, which will give constant protection and instantaneous service. Two 900-kva. synchronous motors, taking power from a 2,300-volt alternating-current cable running from the central power plant, will drive the generators. The direct current generated by the two motor-generator sets will be supplied to various water-tight junction boxes to which the ships' cables can be connected.

Obituary

WILLIAM S. GOULD, president of the Fuel Engineering Company, of New York, died suddenly in his home at Upper Montclair, New Jersey, Jan. 23. Born at Owosso, Mich., Jan. 26, 1865, Mr. Gould received his technical training at the University of Michigan. He was founder of the Fuel Engineering Company, of New York, and its president from 1907 until his death. He was active in engineering affairs, being a member of both the American Society for Testing Materials, and the American Society of Mechanical Engineers. At one time he served as chairman for the Fuels Committee in the latter organization.

Personal Mention

S. H. GRAF, of the engineering school at Oregon State College, has been appointed to the Board of Examiners of Oregon which directs the engineering profession. Mr. Graf succeeds the late Dean G. A. Covell. The appointment was made while Mr. Graf was in the East on a trip.

T. A. MCGEE, mechanical engineer, formerly advisory engineer to the Furnace Engineering Company, Inc., New York City, has now associated himself with F. W. Pennock & Co., Montreal, Canada, in the capacity of vice-president and chief engineer. Mr. McGee will also act as resident engineer for the Furnace Engineering Company, Ltd., Canada; the Montreal address is 1430 Bleury Street.

C. C. HOCKLEY, engineering specialist in the pulp and paper industry, addressed the monthly meeting of the Portland, Oregon, chapter of the Robert Morris associates, on Jan. 10. His subject was "The Pulp and Paper Industry in the Pacific Northwest." Mr. Hockley has had wide experience in the paper industry, having been chief engineer and manager of the Union Bag & Paper company, of New York, and of the Laurentine Paper company, of Grandmere, Quebec, Canada.

Business Notes

THE DAMPNEY COMPANY OF AMERICA, Hyde Park, Boston, announces that the sale of its apexior protective coatings for power plant equipment will be handled in the Province of Quebec, Canada, by W. K. Davidson Co., 332 William St., Montreal.

THE ROLLER-SMITH COMPANY, 233 Broadway, New York City, maker of instruments, relays and circuit breakers, announces the following changes in and additions to its sales organization: S. H. King has been added to the sales force in New York City and will operate in the metropolitan district. Albert Milmow, Latonia Building, Charlotte, N. C., has been appointed exclusive agent for the states of North and South Carolina. M. B. Mathley, Monadnock Bldg., Chicago, Ill., is now exclusive agent for the Chicago territory, superseding M. Frankel, who has been representing Roller-Smith in the Chicago territory for many years.

Trade Catalogs

TELINDICATOR INSTRUMENTS — Th. Goldschmidt Corporation, 68 Beaver St., New York City, has issued catalog No. 3 describing and illustrating the application of Telindicators in connection with canals and locks. The Telindicator instruments cover a large field. They are used, for instance, as engine room telegraphs, in connection with lake vessels, and as rudder indicators.

CENTRIFUGAL PUMPS — The water works pumping equipment of the City of Haverhill, Mass., is described in a four-page leaflet issued by the De Laval Steam Turbine Company, of Trenton, N. J. The city operates two pumping stations, one at Kenoza and the other at Millvale, both of which were originally equipped with reciprocating pumping units. With a view to increasing the water supply and reducing pumping costs, two electric-motor-driven centrifugal pumps have been installed, one having a capacity of a little over 7,000,000 gal. per 24 hours against 90-ft. head, and the other a capacity somewhat in excess of 6,000,000 gal. per day against 211-ft. head.

ELECTRICAL EQUIPMENT — Westinghouse Catalog of Electrical Supplies for 1928-30 has just been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This catalog, which is bound in cloth and contains 1171 pages, supersedes the catalog for 1925-27. The new catalog contains a complete list of supply apparatus and appliances manufactured by the Westinghouse Company, or obtainable through its district office and agent-jobbers. A brief representation of the company's industrial motors and controllers, power and marine equipment, large switchboards, oil circuit breakers and railway apparatus is included. This catalog is more than a listing of equipment, with dimensions, serial numbers and prices. Considerable space has been given to explanations of how the equipment operates, with cross-section drawings to show the construction and suggestions on the application of the equipment are given. For example, the section on lightning arresters is preceded by an article, "Some Facts About Lightning," which is pertinent to the application of lightning arresters. This is followed by a description of the various types of arresters and their fields of application.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Institute of Electrical Engineers, winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention at Hotel Stevens, Chicago, June 25-29.

Chicago Power Show to be held at the Coliseum, Feb. 14-18. G. E. Pfisterer, manager, 53 W. Jackson Blvd., Chicago.

Midwest Power Conference to be held at the Hotel Stevens, Feb. 14-17; G. E. Pfisterer, secretary, 53 W. Jackson Blvd., Chicago.

National Association of Stationary Engineers, annual convention at Detroit, Sept. 11; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Jan. 26, 1928
Navy Standard	New York	$2.25@$2.50
Kanawha	Hampton Roads	1.63@ 1.98
Smokeless	Cincinnati	2.25@ 2.50
Smokeless	Chicago	2.25@ 2.50
S. E. Kentucky	Chicago	1.40@ 1.60
Steam	Pittsburgh	1.40@ 1.65
Gas Slack	Pittsburgh	1.15@ 1.35
Big Seam	Birmingham	2.00@ 2.25
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00@$3.35
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Jan. 26, light oil tank-car lots, 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Jan. 24, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., 5.23c. per gal.

Pittsburg—Jan. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Jan. 26, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

Cincinnati — Jan. 23, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Jan. 20, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Jan. 23, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.8c. per gal.

Dallas—Jan. 21, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Ala., Birmingham — Doster-Northington Inc., 2108 First Ave., awarded contract for the construction of a 5 story stores building to Southern Ferro Concrete Co., 70 Ellis St. N. E., Atlanta, Ga. Estimated cost $500,000.

Ala., Mobile—J. Malbis, 951 Washington Ave., will build a 20 story hotel at St. Francis and Royal Sts. C. P. Tampary, 4318 West End St., Chicago, Ill., is architect.

Calif., Fresno—Pacific Fruit Express Co., 65 Market St., San Francisco, awarded contract for the construction of an ice manufacturing plant to Lynch-Cannon Co., Chapman Bldg., Los Angeles, $261,800.

Calif., Los Angeles—Foreman & Clark, Metropolitan Bldg., awarded contract for a 13 story office, stores and loft building at 7th and Hill Sts. to J. V. McNeil Co., 5860 Avalon Blvd. Estimated cost $1,000,000.

Calif., Los Angeles—Los Angeles County Medical Holding Co., awarded contract for a 13 story office building at Wilshire Blvd. and Westlake Ave. to Scofield-Twaits Co., 621 South Hope St. Estimated cost $794,284. Steam heating and ventilation systems, etc. will be installed.

Calif., Salinas—Monterey County Ice & Development Co., awarded contract for the construction of a cold storage plant to Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles. Estimated cost $200,000.

Calif., San Francisco—A. Penziner, 750 Taylor St., is having plans prepared for a 14 story apartment building at Jackson and Buchanan Sts. Estimated cost $500,000. Private plans.

Calif., Stockton — State of California plans extensions and improvements to Stockton State Armory to include heating plant. Estimated cost $45,000. G. B. McDougall, 615 Forum Bldg., Sacramento, is engineer.

Calif., Watsonville—Apple Growers Cold Storage Co., c/o Trine Service Corp., Central National Bank Bldg., Oakland, Archts., is having plans prepared for the construction of a cold storage plant on Beach Rd., here. Estimated cost $250,000.

Conn., Windsor Locks—Connecticut Light & Power Co., 36 Pearl St., Hartford, has been granted permit to construct a hydro-electric plant and dam on the Connecticut River here to develop 50,000 hp. Estimated cost $2,000,000.

D. C., Washington—City Central Corp., R. A. Nordbloom, Pres., 30 Federal St., Boston, Mass., is having tentative sketches made for the construction of a hotel, auditorium and convention hall at 15th and H. Sts. N. W. Estimated cast $3,000,000. H. Trubauer, Land Title Bldg., Philadelphia, Pa. and Milburn-Heister Co., Hill Bldg., 17th and Eye Sts., are associate architects.

D. C., Washington—National Presbyterian Cathedral, c/o Cram & Ferguson, 248 Boylston St., Boston, Mass., Archts., is having preliminary plans prepared for a cathedral here. Estimated cost $5,000,000.

Ga., Cordele—Crisp County Power Comn., J. J. Williams, Chn., plans the construction of a hydro-electric development on Flint River to develop from 18,000 to 25,000 hp. including power house, 40 x 150 ft. earth dam 3,500 ft. long, and 20 ft. wide, concrete dam 670 ft. long, and 100 ft. wide. Estimated cost $1,250,000. E. S. Killebrew, 206 Broad St., Albany, is engineer.

Ill., Chicago—A. S. Alschuler, 28 East Jackson Blvd., Archt., is receiving bids for a 22 story office and stores building including elevators, etc. at Jackson Blvd. and Franklin St. for B. F. Lindheimer, 77 West Washington St. Estimated cost $2,500,000.

Ill., Chicago—Chicago Civic Opera Co., S. Insull, Pres., 58 East Congress St., plans the construction of a 42 story opera house and office and stores building at Madison, Market and Washington Sts. Estimated cost $20,000,000. Graham, Anderson, Probst & White, 72 East Jackson Blvd., are architects.

Ill., Chicago—Jacob Kulp & Co., 29 South La Salle St., awarded contract for masonry, etc. for an apartment, post office, and stores building West Madison St. and Lotus Ave. Estimated cost $500,000.

Ill., Chicago—Syndicate, c/o M. L. Bein & Co., 64 West Randolph St., Archts., will soon award contract for a 13 story apartment building at 54th St. and Cornell Ave. Estimated cost $1,000,000.

Ill., Chicago—Union Park Apartment Hotel Corp., c/o M. L. Bein & Co., 64 West Randolph St., Archts., is having plans prepared for an 8 story hotel at 1519 Warren Ave. Estimated cost $1,000,000.

Ill., Flossmoor—Syndicate, c/o Newton B. Lauren, 22 West Monroe St., is having plans prepared for six 3 story apartment buildings, club house, etc. Estimated cost $5,000,000. Frank Chase, Inc., 720 North Michigan Ave., Chicago, is architect.

Ill., Lewistown—West Matanzas Drainage & Levee Dist., O. J. Coons, Comr., plans strengthening and repairing leeves on Illinois River, also pumping plant. Estimated cost $58,880. C. H. Kreiling, Havana, is engineer.

Ill., Liverpool—East Liverpool Drainage & Levee Dist., O. E. Gustine, Canton, Comr., plans rebuilding and repairing levees on Illinois River, also revamping pumping facilities. Estimated cost $111,000. C. H. Kreiling, Havana, is engineer.

Ill., Moline—Peoples Power Co., R. D. McDonald, Gen. Mgr., plans extensions and improvements to gas and electric systems including 6 in. steel main from gas plant to 4th Ave. and new high power transmission line from Moline plant to East Moline sub-station, also improvements to stokers in boiler rooms, etc.

Ill., Rockford—City plans the construction of a waterworks pumping station in the Highland Dist. Estimated cost $22,000. H. Wolcott, City Hall, is engineer.

Ind., Fort Wayne—Hilgeman & Schaaf, 209 East Wayne St., will receive bids until Feb. 15 for an 8 story hotel including steam heating system, elevators, etc. at Fairfield and Berry Sts. Estimated cost $1,000,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect.

Kan., Kansas City—Western Refrigeration Co., 21st and Campbell Sts., Kansas City, Mo., awarded contract for the construction of an ice and refrigeration plant at Kansas and Mill Sts., here, to Wyatt & Barcus, 845 Minnesota Ave., Kansas City, Kan. Estimated cost $165,000.

Md., Baltimore—Baltimore Trust Co., 25 East Baltimore St., will soon receive bids for the construction of a 31 story bank and office building including elevators, etc. at Baltimore, Light and Redwood Sts. Estimated cost $3,000,000.

Mass., Fall River—City, W. Pritchard, Ch. Com., is receiving bids for the construction of a technical high school on Rock St. Estimated cost $1,000,000. E. M. Corbett, 70 Bedford St., is architect. J. F. Cullen, 162 Newbury St., advisory archt.

Mass., Lynn—North Shore Ice Co., A. W. Thomas, Pres., 46 Lake St., is having preliminary plans prepared for an artificial ice plant. Estimated cost $40,000. Private plans.

Mich., Eloise—Wayne County Superintendents of Poor, County Bldg., awarded contract for a hospital on Michigan Ave. to Stibbard Construction Co., 3000 Grand River Ave., Detroit. Estimated cost $500,000. Steam heating and ventilation systems, boilers, etc. will be installed.

Mich., Pontiac—J. W. Cook Corp., 612 Genesee Bank Bldg., Flint, Archt., will receive bids about Feb. 1 for a 14 story office building including steam heating and ventilation systems, boilers, elevators, etc. on North Saginaw St. for Peoples State Bank, North Saginaw St., Pontiac. Estimated cost $1,000,000.

Minn., Minneapolis—Chamber of Commerce, J. G. McHugh, Secy., 123 Chamber of Commerce Bldg., will soon award contract for a 7 story office building including steam heating system, elevators, etc. at 4th Ave. S. and 3rd St. Estimated cost $600,000. Bertrand & Chamberlin, Northwestern Bank Bldg., are architects.

Minn., Moorhead—City plans an election Mar. 10 to vote $35,000 bonds for extensions and improvements to municipal light plant.

Mo., Kansas City—City plans an election soon to vote $150,000 bonds for the construction of a central heating plant for municipal buildings.

Mo., Kansas City—Western Refrigeration Co., 21st and Campbell Sts., awarded contract for the construction of an ice plant at 15th and Winchester Sts., to S. Patti Construction Co., 617 Lee Bldg. Estimated cost $150,000.

Mo., St. Louis — Syndicate, c/o J. T. Craven Engineering Co., Century Bldg., Engr., is having preliminary plans prepared for a 15 story hotel including steam heating system, etc. at Pine and Eighth Sts. Estimated cost $1,200,000.

Mo., University City—Syndicate, c/o H. R. Weisels Co. Inc., 730 Chestnut St., St. Louis, has acquired a site and plans the construction of a 6 story office, stores and apartment building including steam heating system, etc. at Delmar Blvd, Heman and Syracuse Sts. Estimated cost $900,000.

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N. J., Camden—Camden River & Harbor Terminal Co., c/o C. H. Moores, 110 East 42nd St., New York, N. Y., awarded contract for the construction of a cold storage plant at Front St. and Kaighn Ave. here, to Cramp Co., Denckle Bldg., Philedelphia, Pa. Estimated cost $1,000,000.

N. J., Elizabeth—Bd. of Comrs., City Hall, is having sketches made for a 15 story office building including steam heating and ventilation systems, boilers, elevators, etc. at Broad St. and Morris Ave. Estimated cost $1,000,000. S. B. Colt, 1259 Clinton Pl., is architect.

N. J., North Bergen—Bd. of Education, Municipal Bldg., will soon receive bids for a high school including steam heating system, etc. at 38th to 39th Sts., Hudson Blvd. and Midway Pl. Estimated cost $850,000. F. Hensel, 254 Summitt Ave., Union City, is architect. W. Weir, 254 Summitt Ave., Union City, is associate architect.

N. J., Rahway—Dept. of Institutions & Agencies, State Capitol, Trenton, will soon award contract for the construction of a refrigeration plant here. Estimated cost $25,000.

N. Y., Binghamton—Rymerbak System, c/o J. W. Ryder, Capitol Theatre Bldg., will soon award contract for an 18 story hotel and garage at Court, Carroll and Chenango Sts. Estimated cost $2,500,000. C. Kiehm, 29 Gardner Bldg., is architect.

N. Y., Brooklyn—Promont Realty Corp., S. Wanxder, 50 East 42nd St., New York, will build a 15 story apartment at Prospect Park W. and Montgomery St. Estimated cost $800,000. E. Roth, 1440 Broadway, is architect. Work will be done by separate contracts.

N. Y., Brooklyn—Union Temple, S. Cohen, 75 Prospect Park W., will receive bids about March 1 for the construction of temple on Eastern Parkway. Estimated cost $1,000,000. A. W. Brunner & Associates Inc., 101 Park Ave., are architects.

N. Y., Huntington—R. J. Reilly, 10 East 41st St., New York, Archt., will receive bids about March 1 for the construction of a seminary here, for R. C. Diocese of Brooklyn. Estimated cost $2,000,000.

N. Y., Jamaica—R. J. Reilly, 10 East 41st St., New York, Archt. will receive bids about Feb. 15 for the construction of a church and monastery here for The Passionists Monastery of Our Lady of the Isle, Union City, N. J. Estimated cost $1,000,000.

N. Y., New York—Jewish Theological Seminary, c/o C. Adler, 531 West 123rd St., plans the construction of a group of college buildings and dormitories at 122nd and 123rd Sts. and Broadway. Estimated cost $1,500,000 to $3,000,000. Architect not selected.

N. Y., New York—Loews Enterprises, 1540 Broadway, are having plans prepared for the construction of a theatre at Concourse and 188th St. Estimated cost $1,000,000. John Eberson, 200 West 57th St., is architect.

N. Y., New York — Mishal Realty Co., Inc., c/o C. Sholtz, 36 West 44th St., had plans prepared for a 10 story office and stores building at 158 West 54th St. Estimated cost $600,000. R. E. Hall, Inc., 231 West 43rd St., is architect.

N. Y., New York — Solid Realty Corp., M. W. Teichman, Pres., 570 7th Ave., had plans prepared for the construction of a loft, office and stores building at 330 West 38th St. Estimated cost $750,000. H. I. Oser, 1440 Broadway, is architect.

N. Y., New York — R. Wilbur Tietjen, Woolworth Bldg., is having plans prepared for a 12 story, plot 125,000 sq.ft. area terminal including warehouse, cold storage plant, etc., at 11th to 13th Aves. and 26th and 27th Sts. Estimated cost $8,000,000. Westcott & Mapes, Inc., Woolworth Bldg., are architects. A. D. Stark, 45 West 45th St., is engineer.

N. Y., White Plains—Bd. Education, R. E. Dougherty, Pres., is having preliminary sketches made for the construction of a high school at Mamaroneck Rd. and Prescott Ave. Estimated cost $1,000,000. Starrett & Van Vleck, 393 7th Ave., New York, are architects.

N. C., Jackson Springs—Jackson Springs & Bad Nauheim Corp., Jackson Springs, or c/o A. J. Westermayr, 14 John St., New York, N. Y., is having plans prepared for a sanitorium including hotel and theatre, swimming pool, etc. here. Estimated cost $1,500,000. George Post & Sons, 101 Park Ave., New York, are architects.

O., Cleveland—The Cleveland Union Terminal Co., C. L. Bradley, Pres., Terminal Bldg., awarded contract for a 15 story terminal building on Public Sq. to John Gill & Sons, Bulkley Bldg. Estimated cost $3,500,000.

O., Columbus—Ohio State University, will receive bids until Feb. 9 for an 84 x 153 ft. chemistry building and 46 x 116 ft. power house. J. N. Bradford, 55 East Oakland Ave., is architect.

Okla., Durant—Oklahoma Gas & Electric Co., Insurance Bldg., Oklahoma City, plans the construction of a cold storage plant here. Estimated cost $40,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill., is engineer.

Okla., Henryetta—City plans an election Jan. 31 to vote $290,000 bonds for waterworks improvements including dam, reservoir, filter plant, pumping equipment, etc. H. M. LeRue, is engineer.

Okla., Mooreland—City, E. Hogan, Clk, will soon award contract for waterworks improvements including deep well pump and motor, etc. Estimated cost $30,000. E. Q. Jones, Enid, is engineer.

Okla., Wyandotte—Seneca Indian School plans the construction of a steam heating plant. Estimated cost $25,000. Private plans.

Pa., Franklin—Chicago Pneumatic Tool Co., awarded contract for extensions to power plant and foundry to Hughes Foulkrod Co., 7th Ave., Pittsburgh.

Pa., Pittsburgh—The Plaza Hotel Co., c/o J. I. Simon, 527 5th Ave., awarded contract for a 25 story hotel on Fifth Ave. to F. T. Ley Co., 578 Madison Ave., New York, N. Y. Estimated cost $2,000,000. Steam heating ventilation and refrigeration systems, boilers; pumps, elevators, etc. will be installed.

Tex., Houston—J. H. Jones, Bankers Mortgage Bldg., awarded general contract for a 35 story office and stores building at Main and Rusk Sts. Estimated cost $3,000,000. H. C. Finn, 505 Bankers Mortgage Bldg., is architect. R. J. Cummings, 727 Bankers Mortgage Bldg., is engineer.

Tex., Houston—Standard Ice Co., c/o C. Nicholas, Auditorium, awarded contract for the construction of an ice plant at Harrisburg and Forest Sts. to J. M. I. West 932 Post Dispatch Bldg. Estimated cost $100,000.

Tex., Midland — City plans an election soon to vote $130,000 bonds for improvements to waterworks and distribution systems, including pumping equipment, etc. Montgomery & Ward, 544 Harvey Snider Bldg., Wichita Falls, Tex., are engineers.

Tex., Presidio—Presidio Ice & Light Co. plans enlarging power plant, will probably install new turbine unit, etc. Estimated cost $60,000. Private plans.

Tex., Quanah—West Texas Utilities Co., Abilene, will soon award contract for the construction of first unit of power plant, 20,000 hp. capacity here. Estimated cost $2,000,000. Private plans. Two additional units will be built later.

Wash., Seattle—C. H. Hagen & Associates, 3322 White Bldg., plans a 37 story office building at Second and Spring Sts. Estimated cost $1,500,000. Lawton & Moldenhour, Century Bldg., are architects.

Wis., Milwaukee—St. Josephs Hospital of Franciscan Sisters, 639 4th St., is having plans prepared for a hospital, nurses home, etc. at Chambers St. and Burleigh Ave. Estimated cost $2,500,000. E. Brillmaier & Sons Co., 425 East Water St., are architects.

Wis., Milwaukee — Terminal Warehouse Co., 274 South Water St., plans the construction of a 5 story terminal including cold storage plant, etc. West Water and Buffalo Sts. Estimated cost $1,000,000. Architect not announced.

Ont., Hamilton—Piggott Healey Co., 36 James St., S., is having plans prepared for a 19 story office building including steam heating system, elevators, etc. Estimated cost $2,000,000. B. H. Prack, 42 James St., N., is architect.

Ont., Toronto—Canadian Bank of Commerce, S. H. Logan, Gen. Mgr., 21 King St. W., will receive bids about Mar. 1 for a 26 story bank and office building. Estimated cost $2,000,000. Darling & Pearin, 2 Leader Lane, are architects.

Ont., Toronto—Sanitary Wholesale Dyers & Cleaners Ltd., Kenwood Ave., P. Rogers, Pres., 78 Vaughan Rd., plans the construction of a dry cleaning plant and boiler room.

Ont., Toronto—Star Publishing Co., 70 King St., W. awarded contract for the superstructure of a 22 story newspaper office and plant to Thompson Starrett Construction Co., 87 King St., W. Estimated cost $2,500,000. Steam heating system, elevators, etc. will be installed.

Que., Quebec City — Quebec Power Co. plans the construction of a power house, 14,000 hp. capacity.

Equipment Wanted

Electrical Equipment—Navigation Dist. Comrs., B. C. Allin, Secy., Houston, Tex., will receive bids until Feb. 2 for electrical equipment and supplies.

Electrically Driven Equipment — Lund Engineering Co., Home Insurance Bldg., Little Rock, Ark., prices and catalogs on equipment that will by means of floats, control the operation of electrically driven pumping machinery in a sewage treatment plant.

Engine—City of Huntington, Ind., is receiving bids for a new 500 kw. turbine engine for municipal light plant, estimated cost $35,000.

Engine—E. B. Merritt, Clk, Anaheim, Calif., will receive bids until Feb. 9 for a 400 hp. international combustion engine.

Engine and Generator—City of Hartshorne, Okla., plans the installation of a Diesel engine and generator in waterworks plant, estimated cost $25,000.

Engine, Generator, Switchboard and Pumping Equipment—City of Vinita, Okla., will soon receive bids for a Diesel oil engine, generator, switchboard and pumping equipment for proposed electric light plant.

Generators, Transformers, Etc.—Light & Power Dept., Los Angeles, Calif., will receive bids until Feb. 28 for electric generators, transformers, exciter generator and auxiliary electrical equipment and appurtances (Spec. P. 421).

Generating Equipment—City of Hannibal, Mo., plans to purchase new generating equipment for proposed improvements to light plant. Estimated cost $150,000.

Generators, Cranes, etc.—Central Bd. of Purchases, Milwaukee, Wis., will receive bids until Feb. 3 for six Foamite (or equal) foam generators, two electric traveling cranes, etc.

Ice Plant Equipment—West Texas Utilities Co., Abilene, Tex., plans to purchase complete equipment for proposed ice plant at Albany, Tex. Estimated cost $35,000.

Motors, Boiler Tubes, Transformers, Air Compressors, etc.—A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Feb. 9 for electric motors, boiler tubes and transformers, also until Feb. 10 for electrical air compressors, (Sched. 1855-1856).

Motors, Elevating and Conveying Machines, etc.—City of Greenville, Tex., plans to purchase machinery and equipment including motors, elevating and conveying machines, etc., for proposed cottonseed plant, estimated cost $16,000.

Power Plant Equipment—City of Monroe, La., plans to purchase complete new motor driven equipment for proposed power plant. Estimated cost $65,000.

Pumping Equipment—Bd. of Contract & Supply, H. R. Holcomb, Secy., Binghamton, N. Y., will receive bids until Feb. 1 for pumping equipment for Trout Brook Sanitary Sewage pumping station.

Pump and Motor—City of Ortonville, Minn., will receive bids until Feb. 6 for a horizontal centrifugal pump direct connected to electric motor with starter equipment for waterworks.

Pump and Motor—Westminster Cemetery Dist., Santa Ana, Calif., will receive bids until Feb. 3 for furnishing and installing a deep well turbine pump with vertical motor, etc.

Pumps—City of Holdenville, Okla., plans to purchase deep well pumps, and pumping equipment for proposed waterworks improvements. Estimated cost $20,000.

Pumps — B. A. Faunce, Clk., East Lansing, Mich., will receive bids until Feb. 27 for pumps, etc., for proposed sewage treatment plant and pumping station.

Pumps and Motors — Village of Patchogue, N. Y., J. P. Losee, Clk., will receive bids until Feb. 7 for 3 in. duplex centrifugal pumps direct connected to 1 hp. electric motors for proposed sewer extensions and pumping stations.

Pumps and Motors—L. E. Shelton, Clk, Marceline, Mo., will receive bids until Feb. 6 for one 1000 and one 650 g.p.m. centrifugal pumps with motors, etc.

Transformers, Meters, Etc.—Modesto Irrigation Dist., Modesto, Calif., is receiving bids for oil and gasoline transformers and meters for one year's supply.